Version 3.2
October 2001

V-DOSC®

OPERATOR MANUAL

FOREWORD

This manual is intended for Qualified V-DOSC Technicians and Certified V-DOSC Engineers who are responsible for the set-up, operation and maintenance of V-DOSC® systems. It is also intended to provide interested sound engineers, designers, consultants and installers with the information they require regarding the fundamental principles of Wavefront Sculpture Technology® and how these principles are embodied within the V-DOSC sound reinforcement system. V-DOSC specifications, installation procedures and general guidelines for sound design are also discussed in this document.

MANUAL ORGANIZATION

The Introduction gives a brief presentation of the V-DOSC system and explains why specialized training is absolutely necessary to set up and effectively use V-DOSC.

- Chapter 1 presents the fundamentals of Wavefront Sculpture Technology and introduces the elements of the V-DOSC system standard
- Chapter 2 describes V-DOSC array performance and coverage prediction
- Chapter 3 discusses elements of sound design and suggested array configurations
- Chapter 4 gives detailed procedures for stacking and flying V-DOSC
- Chapter 5 describes system operation including tuning, operating modes and preset selection
- Chapter 6 lists recommended installation and maintenance tools
- Chapter 7 gives detailed specifications for all elements of the V-DOSC system
- Finally, the Appendices elaborate on a number of technical aspects by providing additional theoretical details

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0. INTRODUCTION

The V-DOSC sound reinforcement system is different. We hope this manual will help you to appreciate why and to understand the basic principles behind how the system works. Understanding these principles will help you to optimally use V-DOSC in sound design – whether for touring or fixed installation. Understanding the concepts behind V-DOSC and Wavefront Sculpture Technology is just as important as learning the many operational details related in this manual – the more you understand the big picture, the more effectively you will use V-DOSC.

As you will see, V-DOSC is a complete system approach – starting from the basic question of how to effectively couple sound sources then including all aspects of sound design, system installation, rigging, cabling, signal distribution, digital control, tuning and performance prediction. This turnkey system approach allows for accurate and predictable results, however, in order to achieve the best results you need to understand the concepts behind how the system works. Since V-DOSC is unique in many ways, this means that specialized training is absolutely necessary.

Apart from sound quality, the system design approach and ergonomics, there are many benefits to V-DOSC. Many of you readers are already aware of these benefits, otherwise they will become apparent throughout the course of this manual.

0.1 WAVEFRONT SCULPTURE TECHNOLOGY FUNDAMENTALS

a) The Sound Reinforcement Problem

The trend in sound reinforcement has been to increase both the actual SPL during concerts and the size of the audience to be covered. This inevitably leads to an increased number of loudspeakers since more powerful single loudspeakers would reach such sizes and weights that their transport, handling and installation would simply not be practical.

In practice, conventional horn-loaded loudspeakers are typically assembled in a fan-shaped array following the angle determined by the horizontal coverage angle of each enclosure in an attempt to reduce overlapping zones that cause destructive interference. With this type of arrangement, the optimum clarity available in one direction can only be provided by the individual enclosure facing in this direction. Attempts at "flattening the array" in order to achieve greater throw and higher sound pressure levels results in severe interference in an uncontrolled way, affecting coverage, pattern control, intelligibility and overall sound quality. Even when arrayed according to specification (always an "optimum" compromise since the polar response of individual horns varies with frequency), the sound waves radiated by individual loudspeakers do not couple coherently (see Appendix 1) thus the conventional system approach is fundamentally flawed. Furthermore, the chaotic sound fields created by interfering sound sources waste acoustic energy, thus requiring more power than a single, coherent source would in order to achieve the same sound pressure level.

To illustrate this, consider what happens when we throw pebbles in the water. If we throw one pebble into the water, we can see circular waves expanding from the place where it disturbed the surface. If we throw a handful of pebbles, we observe what is termed a chaotic wavefield. If we throw a larger stone, with total size and weight equivalent to the handful of pebbles, then we see circular waves as was obtained with the single pebble, except now with much larger amplitude. If all of the individual pebbles of the handful could be glued together, this would provide the same effect as the larger stone...

This illustrates the thinking behind V-DOSC: if we can build a single sound source from a number of individual speakers that can be separated for transport and handling, then we have achieved our goal, i.e., to provide a totally coherent, predictable wavefield.

Therefore, the initial specification at the beginning of the V-DOSC research and development program was the design of a single acoustic source that was to be completely modular, predictable and adjustable.

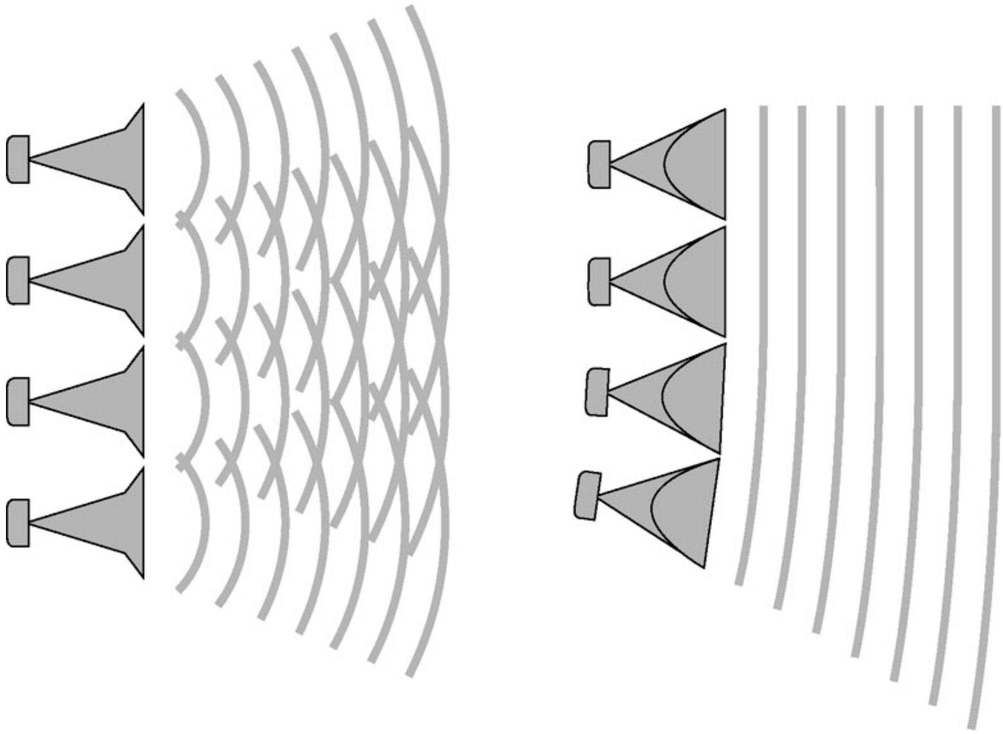

Figure 1: Wavefield interference for a conventional sound reinforcement system compared to a sculptured V-DOSC wavefield

b) Wavefront Sculpture Principles

As early as 1988, a preliminary system named "Incremental" had proven the feasibility of V-DOSC. From this experimental concept, theoretical research was undertaken by Professor Marcel Urban and
Dr. Christian Heil. The results of this research were presented during the 92nd AES convention in Vienna, March 1992 (preprint n°3269).

The theory that was developed defines the acoustic coupling conditions required for effectively arraying individual sound sources. Relevant parameters include: wavelength, the shape of each source, the surface area of each source and the relative source separation.

In brief, the WST coupling conditions can be summarized as follows:

An assembly of individual sound sources arrayed with regular separation between the sources on a plane or curved continuous surface is equivalent to a single sound source having the same dimensions as the total assembly if one of the two following conditions is fulfilled:

1) Shape: The wavefronts generated by the individual sources are planar and the combined surface area of the sources fills at least 80% of the target surface area.

2) Frequency: The step or source separation, defined as the distance between the acoustic centers of the individual sources, is smaller than half the wavelength at all frequencies over the bandwidth of operation.

These two criteria form the basis of Wavefront Sculpture Technology (referred to as WST throughout this text). For further information, more detailed theory is presented in Appendix 3.

Additional WST Criteria were developed for the AES preprint entitled "Wavefront Sculpture Technology" that was prepared for the 111th Convention, NYC, Sept 2001 (preprint # not available). The first two WST Criteria were re-derived based on an intuitive approach using Fresnel analysis and in addition it was shown that:

3) The deviation from a flat wavefront must be less than $\lambda/4$ at the highest operating frequency (this corresponds to less than 5 mm curvature at 16 kHz)

4) For curved arrays, enclosure tilt angles should vary in inverse proportion to the listener distance (geometrically this is equivalent to shaping variable curvature arrays to provide equal spacing of individual element impact zones)

5) Limits exist given the vertical size of each enclosure and the relative tilt angles that are allowed between enclosures.

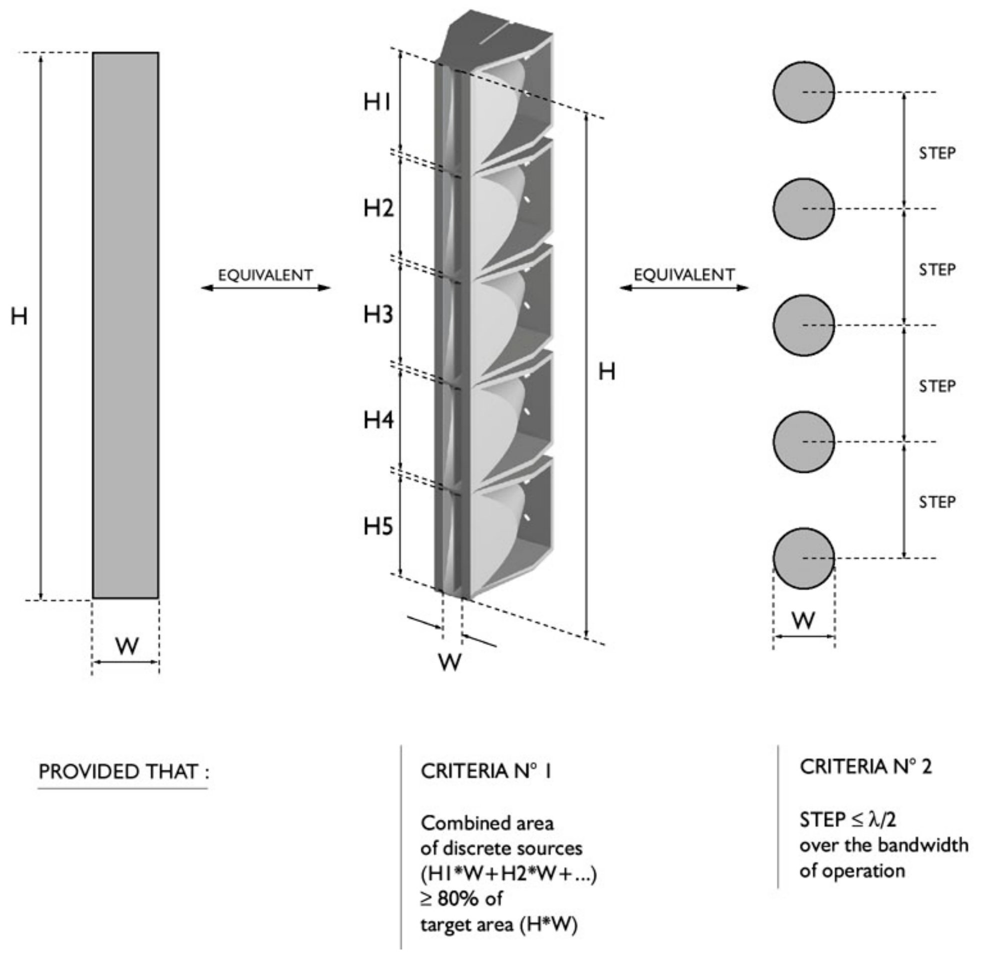

Figure 2: Wavefront Sculpture Technology Criteria Illustrated

c) V-DOSC - The Solution

V-DOSC is the first exact embodiment of the principles of Wavefront Sculpture Technology. V-DOSC stands for "Diffuseur d'Onde Sonore Cylindrique" – in English this means Cylindrical Sound Wave Generator. The "V" in V-DOSC refers to the V-shaped acoustic lens configuration employed for the mid and high frequency sections.

V-DOSC was designed as a system consisting of identical, vertically-arrayable elements. Individual transducers are physically arranged within each enclosure so as to meet WST criteria, frequency band by frequency band, when the enclosures are arrayed together. Each element radiates a flat isophasic (constant phase) wavefront, allowing the overall assembly of multiple elements to produce a single extended sound source. Since the angle of separation between adjacent elements is adjustable, the wavefront can be focussed by physically shaping the array. Through successful coupling over the entire audio frequency range, V-DOSC produces a consistent wavefront over a large area with very little fluctuation in frequency response and sound pressure level.

The heart of the V-DOSC system is the internationally patented[1] DOSC waveguide. Essentially, the DOSC waveguide permits fulfillment of the first condition of WST for frequencies higher than 1.3 kHz, i.e., the wavefronts generated by individual DOSC waveguides are planar and their combined surface area accounts for at least 80% of the target surface area provided that the relative angle between adjacent enclosures remains less than 5 degrees. For traditional horn-loaded systems, coherent summation is simply not possible at higher frequencies since the wavelength becomes progressively smaller than the physical separation between horn and driver assemblies and neither of the two WST criteria can be satisfied. As a result, interference occurs throughout most of the assigned high frequency range (see Appendix 1).

By comparison, a V-DOSC array is a full-spectrum, coherent speaker system even for the highest frequencies. As with any speaker system, interference does in fact occur for the case of V-DOSC, however the main difference is that within the defined coverage region the interference is constructive, while outside of the defined wavefield it is destructive (see Appendix 2). For more details on how V-DOSC satisfies WST criteria, please refer to Appendix 3. For further information on the actual DOSC waveguide, please see Appendix 4.

V-DOSC elements are vertically arrayed in two or four characteristic "J" shaped columns. Since elements of the array couple coherently, the enclosures are physically smaller and fewer cabinets are required in comparison with conventional systems. This makes V-DOSC very cost effective for touring sound applications where transport space and handling time means money. These properties also make V-DOSC highly effective for fixed installation where compact size combined with predictable coverage is important.

One of the key benefits of WST is the predictability of the wavefront's shape. Horizontally, the entire V-DOSC array has the same coverage angle as a single element (90°). Vertically, the coverage is directly determined by the number of arrayed elements and the specified angle of separation between them. Given this predictability, vertical coverage can be optimized to match specific audience area requirements. A quick, user-friendly CAD spreadsheet helps the operator to determine how to focus the wavefield so that tonal balance and sound pressure levels are evenly distributed throughout the listening area. Using this program, array design can be conveniently performed on a case-by-case basis to optimize coverage for each venue according to the specific audience layout.

The configuration of transducers in a V-DOSC element is symmetrical with respect to the plane of propagation of the wave, i.e., the plane bisecting the horizontal coverage angle. High frequency transducers are located in the middle, mid frequency transducers are on both sides of the high section, and low frequency transducers are laterally positioned on both ends. Such a configuration is described as having COPLANAR SYMMETRY.

Coplanar symmetry is the cylindrical domain equivalent of the coaxial arrangement for individual (spherical) sources. Essentially, coplanar symmetry allows for homogeneous coverage of the sound field at any listening angle over the V-DOSC array's 90° horizontal coverage window. Coplanar symmetry also eliminates off-axis acoustic cancellations at crossover frequencies so that polar lobing is not an issue. Psychoacoustically, coplanar symmetry is largely responsible for the exceptional stereo imaging properties that are characteristic of V-DOSC.

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[1] ***The DOSC waveguide is registered under European patent n°0331566 and North American patent n°5163167. Please see Appendix 4 for a description of the DOSC waveguide.***

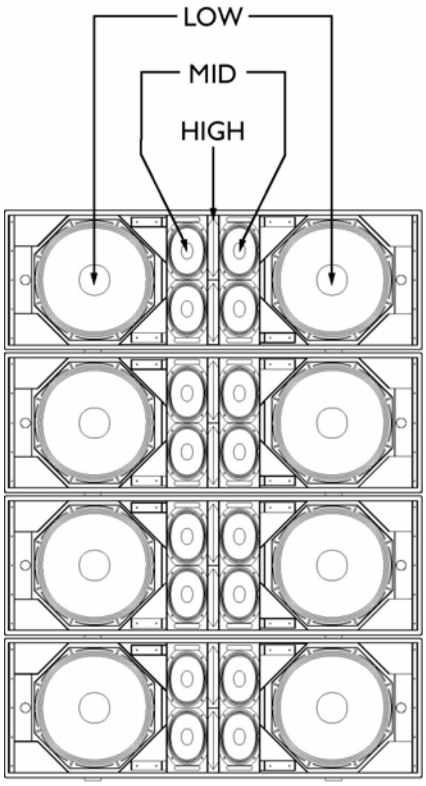
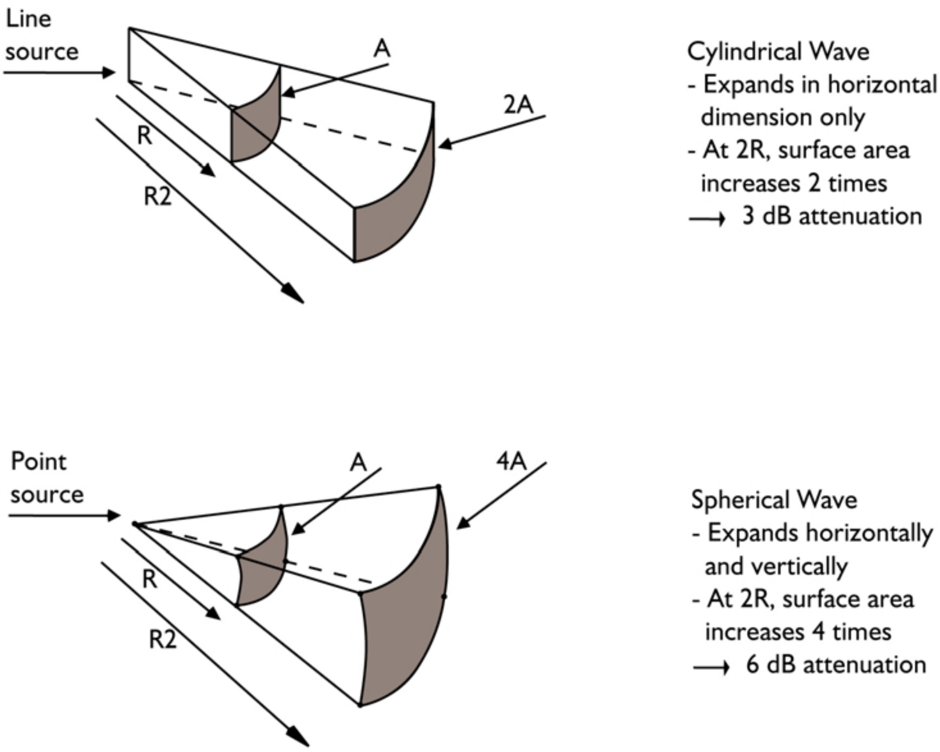


Figure 3: Coplanar Symmetry of V-DOSC

Apart from coverage precision and predictability, another significant benefit of V-DOSC is the fact that the system effectively extends the near field region at higher frequencies. For flat V-DOSC arrays, this results in a 3 dB reduction in SPL with doubling of distance as opposed to the 6 dB reduction that is typical of conventional systems. This property arises due to the physics of cylindrical waves versus spherical waves (see the figure below and Appendix 5 for further details).



This means that V-DOSC should not be evaluated in terms of the classical "$ / kilowatt"-ratio, i.e., due to it's ability to generate cylindrical wavefronts, V-DOSC has different attenuation properties than conventional systems. Comparing SPL predictions according to standard calculations is not meaningful since V-DOSC produces a combination of cylindrical and spherical wavefront propagation that must be evaluated using specific calculations.

Aside: This is one of the reasons why modelling data is not available for V-DOSC and other WST-based systems manufactured by L-ACOUSTICS. EASE and CATT data are provided for more conventional products manufactured by L-ACOUSTICS. We are currently working with the developers of room acoustics modelling software packages in order to provide WST-based system simulation.

When curved V-DOSC arrays are employed there is a combination of cylindrical and spherical propagation. This combined propagation, together with the actual shape of the audience allows the wavefield to be focused so that tonal balance and sound pressure levels are evenly distributed throughout the listening area. Although pure cylindrical wave propagation is not always in effect, 3 dB reduction with doubling of distance can still be obtained along with extension of the nearfield - this is the benefit of WST and also the reason why correct focus of the system on the audience area is so important.

Psychoacoustically, nearfield extension allows one to walk a considerable distance from a V-DOSC system with only a small difference in SPL due to the system's unconventional attenuation rate. Effectively, more of the audience experiences nearfield listening, enjoying higher fidelity, improved stereo imaging and exceptional clarity. Subjectively, the loudspeakers seem much closer and the sound is "in your face". Image localization is towards the action on stage - not the loudspeaker arrays. Practically, this extension of the nearfield means that extreme sound pressure levels are not required close to the system in order to provide acceptable SPLs further back in the audience - this is a highly desirable property that also results in reduced potential for hearing loss for both audiences and engineers alike.

Nearfield extension, combined with the precision and predictability of V-DOSC coverage is also effective in "pushing back" the critical distance in highly reverberant spaces (critical distance is defined as the distance where the energy of the direct sound is equal to the reverberant energy). In many situations, it is extremely important to keep energy off the roof, for example in outdoor sheds, amphitheatres, and arenas. If we can excite less of the reverberant energy in the room and focus more energy on the audience, we can effectively move back the critical distance in a given room. Given the well-defined vertical coverage of V-DOSC, the benefits of WST become immediately obvious in comparison with conventional systems when working in difficult rooms.

Finally, another benefit of WST is the high degree of SPL rejection that is obtained outside of the defined wavefield. Nominally as high as 20 dB, this permits the installation of a V-DOSC array behind or above microphones with exceptionally high feedback immunity. Monitor engineers also enjoy working with V-DOSC FOH systems since there is very little backwave on stage - even at lower frequencies due to the coplanar symmetric arrangement and vertical line array configuration of the low section (for larger arrays of up to 16 elements, pattern control is obtained down to as low as 80 Hz). High SPL rejection outside of the defined coverage region also makes V-DOSC an excellent solution in situations where environmental noise control is an issue, for example, in situations where outdoor amphitheatres are located close to residential areas.

The accuracy, flexibility and predictability inherent in the V-DOSC approach to sound reinforcement opens up many new horizons for sound design.

0.2 V-DOSC TRAINING AND QUALIFICATIONS

V-DOSC is an innovative design which is based on a completely new approach to sound reinforcement. It can provide fully predictable results to the extent that no other existing system is capable of. However, achieving the desired results requires following a rigorous procedure which may at first seem unusual to some sound designers and engineers. Hopefully, most of you will embrace this new technology and approach V-DOSC with an open mind, excited by the many new possibilities that such a system makes available.

However, it can be “hard to teach an old dog new tricks”. For those of you in this category, the very first step to take is to forget your experience with other systems, overcome your biases and forget all the tricks you have learned from past experience. Try to accept the fact that THIS SYSTEM BEHAVES DIFFERENTLY! V-DOSC cannot be left in the hands of someone who has no experience with the system - even if that person has great skills and experience with respect to other systems. A V-DOSC operator unquestionably needs specific training and there are two levels of qualification:

THE QUALIFIED V-DOSC TECHNICIAN (QVT)

The responsibilities of a Qualified V-DOSC Technician are: equipment preparation, system design using ARRAY software (on-site measurements or from architectural plans), system installation (rigging, assembly, cabling, system focus, preset selection and drive rack configuration), system testing/tuning and assisting the FOH mix engineer. The QVT is a sound technician with demonstrated ability who has been chosen for his or her technical expertise by a given V-DOSC Network service provider. To be included in the official list that is distributed to members of the V-DOSC Network, the QVT has to meet the following criteria:

- Must be recommended by a recognized CVE or an official representative of the V-DOSC Network
- Must have participated in V-DOSC training sessions on theory and rigging.

THE CERTIFIED V-DOSC ENGINEER (CVE)

The higher level of qualification is termed "Certified V-DOSC Engineer" or CVE. In addition to satisfying the mission statement for Qualified V-DOSC Technicians (see above) the CVE has further expertise in the areas of: sound design and system measurement as well as extensive real world experience with V-DOSC. The CVE has a deep theoretical understanding of Wavefront Sculpture Technology based systems (including V-DOSC, ARCS and dV-DOSC) with a full grasp of the operating theories and principles behind the system. The CVE is capable of recommending and endorsing QVTs along with supervising the QVTs during their apprenticeship period towards becoming a full CVE. In some cases, CVEs may also conduct V-DOSC training sessions.

To be included in the official CVE list that is distributed to members of the V-DOSC Network, the operator has to meet the following criteria:

- Must be recommended by a recognized CVE or official representative of the V-DOSC Network
- Must have participated in V-DOSC training sessions on theory and rigging
- Must be known and certified by an official representative of L-ACOUSTICS.

The Qualified V-DOSC Technician and Certified V-DOSC Engineer are important representatives of the V-DOSC Network. While the V-DOSC Network provides the V-DOSC system on a rental basis, it is the QVT and/or CVE who accompanies the system at each installation to ensure that system performance is optimal. We hope that you carefully follow the guidelines presented in this manual - it is in everyone’s best interest that V-DOSC is deployed correctly and optimally in the field.

NOTE: L-ACOUSTICS provides QVT training seminars in North America, Europe and at the factory in France (please contact L-ACOUSTICS for the latest training schedule). In some cases, training can be provided on site.

1. V-DOSC: THE UNIVERSAL STANDARD

1.1 IDENTIFICATION OF THE COMPONENTS OF THE SYSTEM

a) Universal V-DOSC Standard

A V-DOSC system is a complete, self-contained FOH sound reinforcement system consisting of loudspeaker enclosures, amplifier racks, flying hardware, dedicated control and signal processing, packaging, cables and connectors. V-DOSC system elements have been carefully selected by L-ACOUSTICS for their specific quality and long term reliability. Together, the elements of the system form a Universal Standard for V-DOSC.

The benefits of a standard version of the V-DOSC system include:

- Total compatibility between all V-DOSC partners for cross rental purposes.
- Long term & common experience shared by all QVTs and CVEs.
- Very flexible packaging which is not dedicated to one specific application.
- High standards of quality control ensuring that V-DOSC system performance is consistent for all Network Partners world wide resulting in enhanced end user confidence.

The V-DOSC system does not include chain motors, mains distribution or external handling gear, nor does it include upstream signal mixing and processing equipment. In general terms, the V-DOSC system is capable of producing sound from a line-level signal in any concert situation.

System block diagrams are presented below to provide an overview of system connection and signal flow. This is followed by an identification of the individual components of the system and more detailed descriptions in Sections 1.2 through 1.7.

Please note that specific multiconductor connector selection for system drive remains open for the user to define although L-ACOUSTICS does recommend a specific connector type that is supplied with turnkey systems. L-ACOUSTICS recognizes the fact that multiconductor snakes and connectors represent a significant investment and many users already have their own internal standard that they must adhere to. Therefore, this part of the Universal Standard remains flexible. Specific multiconductor connectors can be accomodated on special request - the only components that need to be customized are the CONTROL RACK OUTPUT panel and the MULTI DISTRO panel.

Other elements that must remain standard in order to ensure compatibility include: multiconductor line assignments; crossover channel assignments and presets; amplifier rack connectors for speaker connection; amplifier rack connectors and channel assignments for signal distribution. In addition, L-ACOUSTICS specifies only approved amplifiers and digital processors for use with V-DOSC.

NOTE: Some V-DOSC systems available on the market do not comply with the Universal Standard and are considered non-approved by L-ACOUSTICS. For the case of custom, non-standard systems, L-ACOUSTICS does not accept responsibility for misuse or misoperation and in some cases, the warranty may be considered void. L-ACOUSTICS encourages all users to comply with the recommended standard as closely as possible in order to maintain approved status.

b) General V-DOSC System Block-Diagram

A general block diagram representation of V-DOSC system components, cabling and signal flow is given in Figure 4. Please refer to this for a general overview of the system.

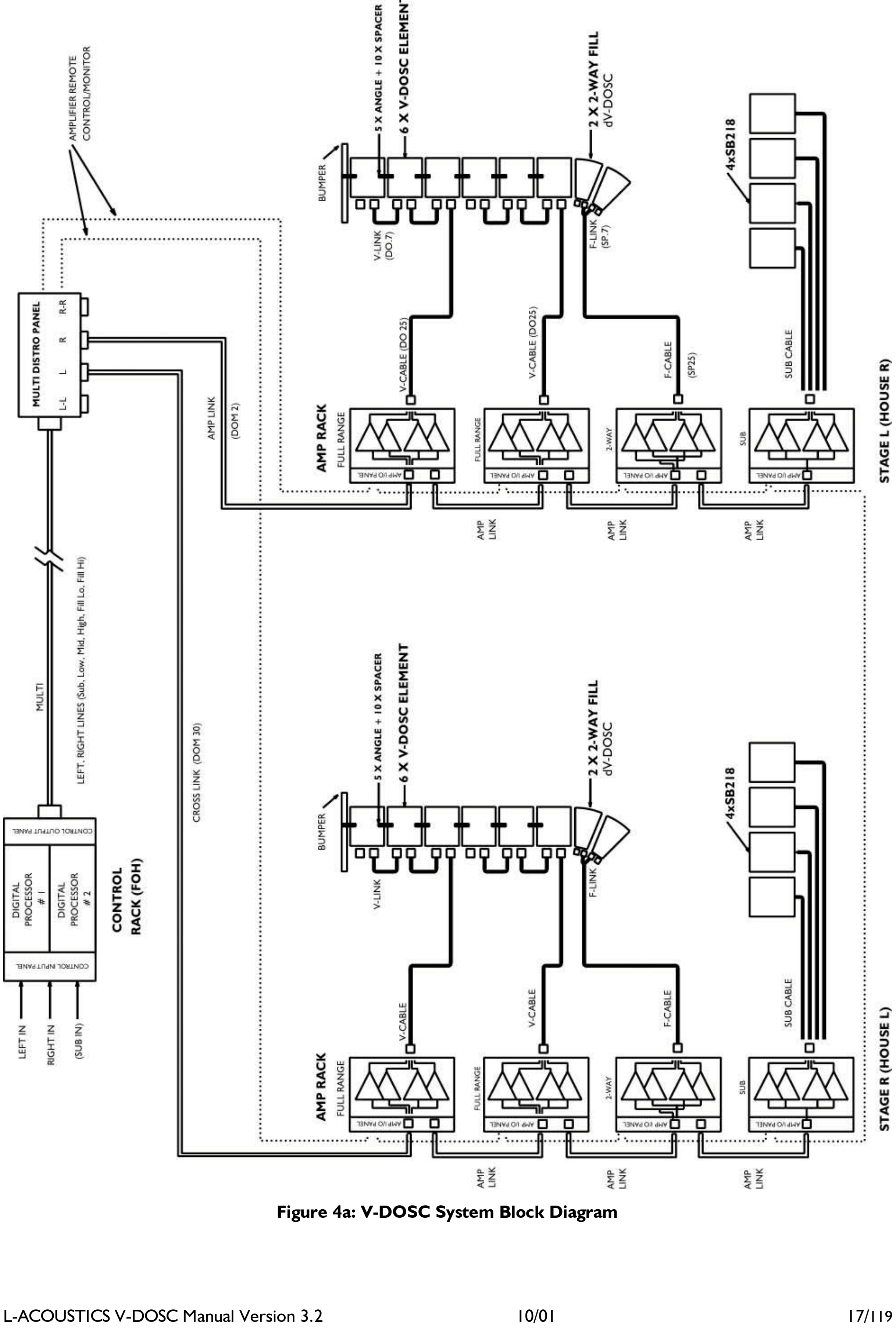


Figure 4a: V-DOSC System Block Diagram

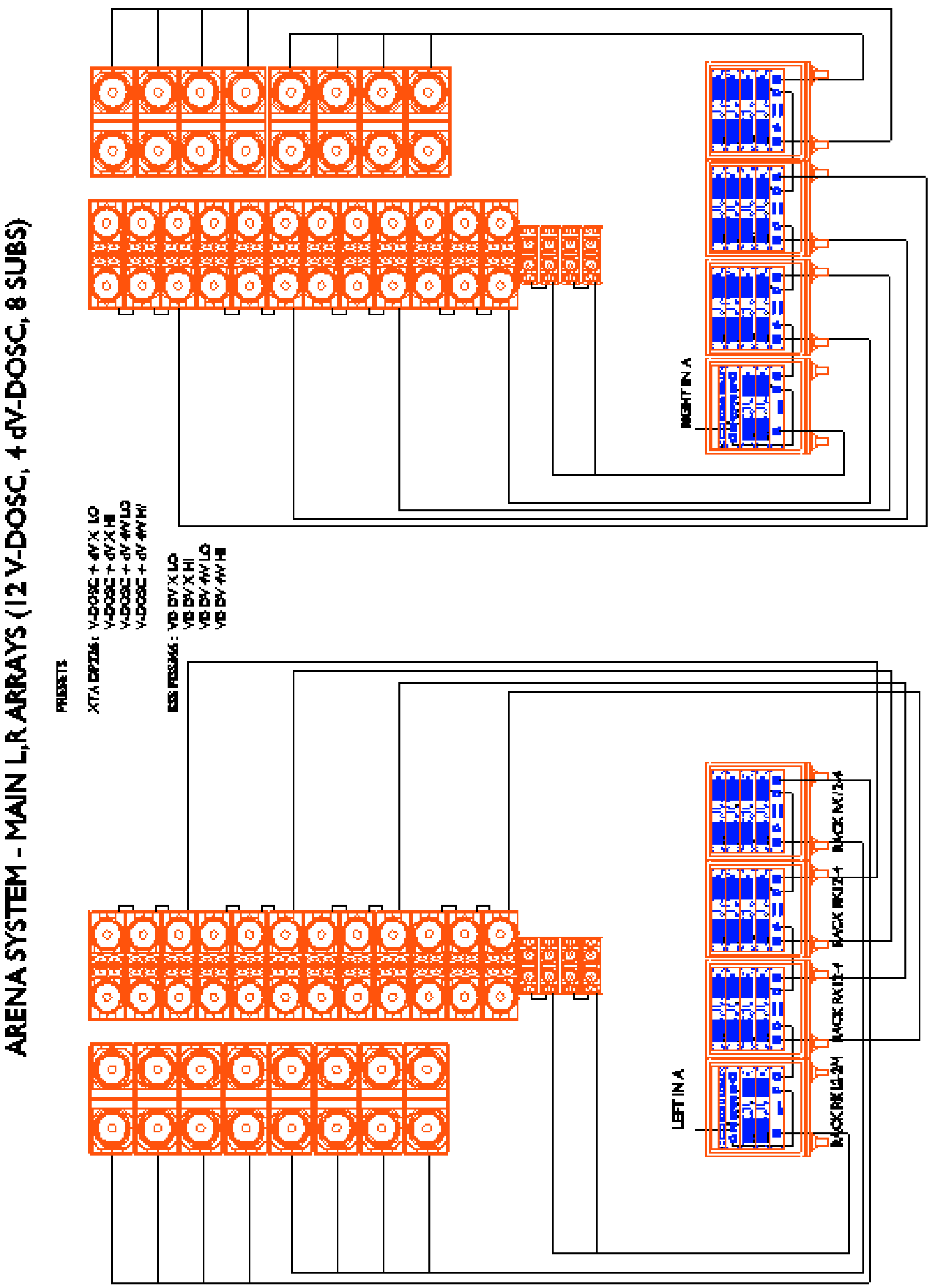


Figure 4b: Example System Configuration

c) V-DOSC System Components

(1) **V-DOSC**
Full-range 3-way loudspeaker enclosure, meeting WAVEFRONT SCULPTURE TECHNOLOGY criteria, with coplanar symmetric arrangement of drivers.

(2) **SB218**
Complementary subwoofer for high level, extended bandwidth applications.

(3) **CONTROL RACK**
Control rack for system drive containing digital processors with custom engineered system presets, CO24 control output panel.

(4) **AMP RACK (RK12U)**
Complete amplifier rack, containing four L-ACOUSTICS LA 48 amplifiers and V-DOSC PAD04 AMP panel. Also includes PADOSEC mains distribution panel. Can be configured for powering V-DOSC elements, 2-way fill enclosures or subwoofers.

(5) **CONTROL OUTPUT PANEL (CO24)**
Output panel for the CONTROL RACK with: 1x 84 pin MASS connector; 4x 19 pin male CA-COM connectors; 24x female XLR inputs on the internal side; 1x male/female 4-pin XLR pair for amplifier remote control/monitoring. Used for connecting digital signal processor outputs and amplifier remote control/monitoring to MULTI return snake lines.

(6) **V-DOSC AMP PANEL PAD04**
Amp rack panel suitable for 4 amplifier per rack configurations. Connectors include: 2x 8 pin female CA-COM (for loudspeaker connection); 1x male 19 pin CA-COM (for input signal connection); 1x male 19 pin CA-COM (for jumping to other amp racks); 2x COMB (for changing between 2-way, 3-way and subwoofer operating modes); 2 pairs of 4x male XLR and 4x Speakon fanouts on the internal side (for connecting signal to amplifier inputs and outputs).

(7) **V-DOSC AMP PANEL PADO2**
Amp rack panel suitable for 2 amplifier per rack configurations. Connectors include: 1x 8 pin female CA-COM (for loudspeaker connection); 1x male 19 pin CA-COM (for input signal connection); 1x male 19 pin CA-COM (for jumping to other amp racks); 1x COMB (for changing between 2-way, 3-way and subwoofer operating modes); 4x male XLR and 4x Speakon fanouts on the internal side (for connecting signal to amplifier inputs and outputs).

(8) **MULTI DISTRO PANEL (MD24)**
Stage distribution panel with 1x 84 pin MASS connector (for connection of MULTI return snake from FOH), 4x 19 pin male CA-COM (for distribution of Left-Left, Left, Right, Right-Right signal lines), 1x male/female 4-pin XLR pair (for distribution of amplifier remote control).

(9) **BUMPER2**
Flying structure for hanging a V-DOSC array. Can also be inverted and used as an adjustable base for stacking a V-DOSC array.

(10) **ANGLE STRAPS**
Used to provide spacing between V-DOSC elements when stacked or flown. Values: 0.75° or 5.5°; 1.3°; 2°; 3°; 4° (Part Codes: BUMP24; BUMP251; BUMP25; BUMP26; BUMP27)

(11) **SPACER**
Used with ANGLE STRAPS to provide the desired spacing between V-DOSC elements when stacked or flown. (Part Codes:; SPAC251=1.3°; SPAC25=2°; SPAC26=3°; SPAC27=4°; SPAC28 =5.5° for use with corresponding BUMPxx).

(12) **MULTI (MC2875)**
28 pair multiconductor return snake, 100 m (325 ft) length, fitted with 84 pin MASS connectors at each end (used for connecting CONTROL OUTPUT panel, typically located at FOH, to MULTI DISTRO panel for subsequent distribution of drive signal to the amplifier racks)

(13) **AMP LINK (DOM2)**
6 pair multiconductor cable, 2 m (6.5 ft) length, with 2x female 19 pin bayonet CA-COM connectors (for distributing signal from MULTI DISTRO panel to amplifier racks and for jumping between AMP RACKS)

(14) **CROSS LINK (DOM30)**
6 pair multiconductor cable, 30 m (100 ft) length, with 2x female 19 pin bayonet CA-COM connectors (for cross-stage connection from MULTI DISTRO panel to amplifier racks)

(15) **LINK-EXTEND (DOMP)**
19 pin male/male CA-COM adapter (for connecting two AMP LINK or CROSS LINK cables when longer lengths are required)

(16) **LINK-BREAKOUT (DOMM)**
Multipair cable adaptor consisting of 1x female 19 pin CA-COM connector at one end, 6x male XLR connectors at the other (used as a LINK cable breakout for patching and testing purposes)

(17) **LINK-BREAKOUT (DOMF)**
Multipair cable adaptor consisting of 1x female 19 pin CA-COM connector at one end, 6X female XLR connectors at the other

(18) **V-CABLE (DO7, DO25)**
Main V-DOSC loudspeaker cable, 8 conductor, 7 m (20 ft) or 25 m (80 ft) length, equipped with male/female CA-COM type connectors (for connecting V-DOSC elements to the amplifier rack)

(19) **V-LINK CABLE (DO.7)**
V-DOSC loudspeaker link cable, 8 conductor, 0.7 m (2 ft) length, equipped with male/female CA-COM type connectors (for parallel connection of V-DOSC elements)

(20) **F-CABLE (SP7, SP25)**
Fill loudspeaker cable, 4 conductor, 7 m (20 ft) or 25 m (80 ft) length, equipped with CA-COM to 2x Speakon connectors (for connecting 2-way fill enclosures to the amplifier rack)

(21) **F-LINK CABLE (SP.7)**
Fill loudspeaker link cable, 4 conductor, 0.7 m (2 ft) length, equipped with Speakon connectors (for paralleling 2-way fill enclosures)

(22) **SUB CABLE (DOSUB)**
Subwoofer loudspeaker cable, 5 m (16 ft) length, with male 8 pin CA-COM connector and four Speakon connectors (for connecting 4x SB218 subwoofers to the amplifier rack)

(23) **SUB EXTENSION CABLE (DO10P)**
Subwoofer extension cable ,10 m length for use with DOSUB

(24) **DELTA PLATE (BUMPDELTA)**
Used to attach two motors to the rear fly point of the BUMPER – allows for pan adjustment of a flown V-DOSC array

(25) **SB218 FLYING BAR**
Flying bar for rigging up to eight SB218 enclosures deep in a vertical line array

(26) **DO2W, DOFILL**
Adaptor cables for use with PAD02 or PAD04 and 2-way COMB connector for powering 2-way fill enclosures. DO2W allows direct connection to the panel, DOFILL is used with V-CABLE.

V-DOSC

SB 218

AMP RACK RK12U

AMP PANEL PADO2

AMP PANEL PAD04

MULTI DISTRO MD24

CONTROL OUTPUT CO24

BUMPER2

ANGLE STRAPS

DELTA PLATE

SB 218 FLYING BAR

SPACER

MULTI MC2875

AMP LINK DOM2

CROSS LINK DOM30

LINK EXTEND DOMP

LINK BREAKOUT DOMF

V-CABLE DO7

V-LINK CABLE DO.7

F-CABLE DO7

F-LINK CABLE DO.7

DO2W

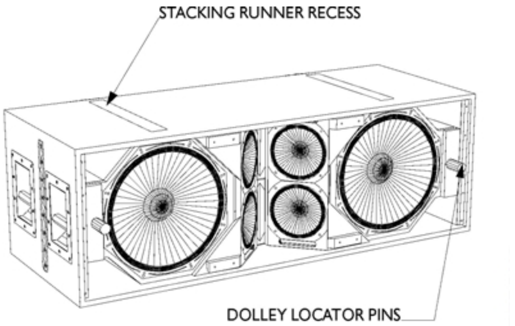
DOFILL

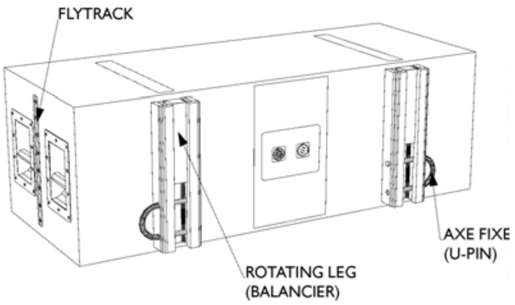
SUB CABLE DOSUB

SUB EXTENSION DO10P

Figure 5: V-DOSC System Parts and Accessories

1.2 V-DOSC ELEMENT SPECIFICATIONS





Dimension (WxHxD):	1300mm x 434mm x 565mm (51.2" x 17.1" x 22.2")
Weight:	108 kg (238 lbs) + 9,5 kg (21 lbs) with dolley

Figure 6: V-DOSC Element - Front and Rear Views

The V-DOSC element is a full range 3-way enclosure which is designed to be vertically arrayed and forms the core of the V-DOSC system. It embodies Wavefront Sculpture Technology and completely fulfills the WST arrayability criteria defined above. The key to the performance of the V-DOSC element is the DOSC waveguide – two devices are used in each enclosure to load two compression drivers. All components of a V-DOSC array are symmetrically arranged with respect to a plane vertically bisecting the array (coplanar symmetry).

The enclosure contains 2X 15" loudspeakers (connected separately), 4X 7" midrange loudspeakers (connected in series/parallel) and 2X 1.4" compression drivers (connected in series) which are mounted on 2X DOSC waveguides. All components are weather-resistant.

Although it is a 3-way design, the enclosure is driven by 4 amplifier channels. A V-DOSC element is connected to the AMP RACK by V-CABLE (7 m or 25 m length, as required) where the connector employed is an 8 pin Cannon CA-COM of the bayonet-locking type. Each V-DOSC element is provided with two connector sockets for direct connection and for paralleling of up to three enclosures (elements are paralleled using V-LINK DO.7 jumper cables).

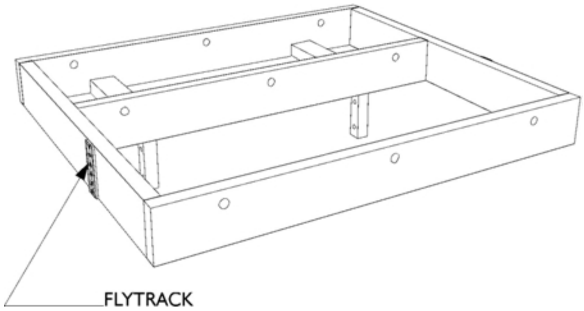
The rectangular shape of the enclosure allows for easy stacking, transport and handling. A front mounted dolley board is provided for protection and transportation. Stacking runners located on the bottom of the cabinet act as skid pads to protect the cabinet finish and mate with stacking runner recesses on the top of the enclosure for enhanced stability when stacking. Cabinet dimensions were designed to allow for efficient truck packing for a variety of trailers of standard sizes.

Flying a V-DOSC array is particularly easy, fast and secure. The V-DOSC element features a unique flying system where built-in flying hardware extends from cabinet-to-cabinet to the hanging points on the BUMPER flying structure in a caterpillar-like fashion. Two rotating legs (Balanciers) are located on the rear of each cabinet and are physically attached to the other cabinets using U pins (Axfixe). Cabinets are physically connected while lined up on the floor and the complete array is flown all at once (in comparison with other systems where cabinets are flown row-by-row). The only external

parts needed are ANGLE straps and SPACER blocks – these accessories are used to adjust the angle between adjacent elements in the array (see Chapter 4 for full details on flying and stacking V-DOSC).

The bandwidth of the V-DOSC array is 50 Hz to 20 kHz (± 3 dB). For rock applications, the addition of SB218 subwoofers is recommended in order to extend the response to 25 Hz and to increase the available headroom in the extreme low frequency range. Please see Section 3.4 for full details on using V-DOSC with subwoofers.

1.3 V-DOSC FLYING SYSTEM



Dimension (WxHxD):	1262mm x 140mm x 1100mm (49-5/8" x 5-4/8" x 43-3/8")
Weight:	61.5 kg (135.6 lbs)

Figure 7: V-DOSC BUMPER

The BUMPER flying structure is made of a rectangular steel main frame with heavy duty cross bracing. Rigging accessories required for flying and stacking V-DOSC include: 8 shackles, 4 steel slings, 2 pear rings, 4 screwjacks, 2 ratchet straps plus ANGLE straps and SPACER blocks.

The two rotating legs (Balanciers) along with U-shaped locking pins (Axfixe) located on the bumper are used to hang the first V-DOSC element of the array. There are also two vertically-oriented Aeroquip flytrack "E-rails", allowing for attachment of the first element to the BUMPER using the BUMP angle strap.

When flown, the BUMPER is hung from two points spaced by 1.05 m (43 ¼") - one front and one rear. The center of gravity of the whole array is exactly vertical from the line joining these two points. Motors can be attached to the central hole locations on the bumper or, alternatively, for additional safety factor when flying large arrays, the two outer hole locations (front and rear) can be used for bridling using 4 steel slings (2 front, 2 rear), 8 shackles and 2 pear rings.

A unique feature of the V-DOSC flying system is the fact that the relative action of the front and rear chain motors can adjust the vertical angle of the entire array since the array is connected rigidly to the BUMPER. Although ANGLE straps determine the angle between adjacent V-DOSC elements, the rear rotating legs of the caterpillar-type assembly provide the mechanical connection and bear the majority of the load. As the array is tilted upwards, weight is progressively distributed from the rotating legs to the ANGLE straps. As a result, the maximum upward tilt angle is approximately 5 degrees. Note: detailed mechanical load calculations can be performed using ARRAY 2000 software to determine exact array tilt angle limits.

NOTE: A single BUMPER can safely fly an array of up to 16 V-DOSC elements. Chain motor ratings for each fly point are as follows: 0.5T motor per point for a 4-element array; 1.0T motor per point for a 5- to 10-element array; 2.0T motor per point for an 11- to 16-element array.

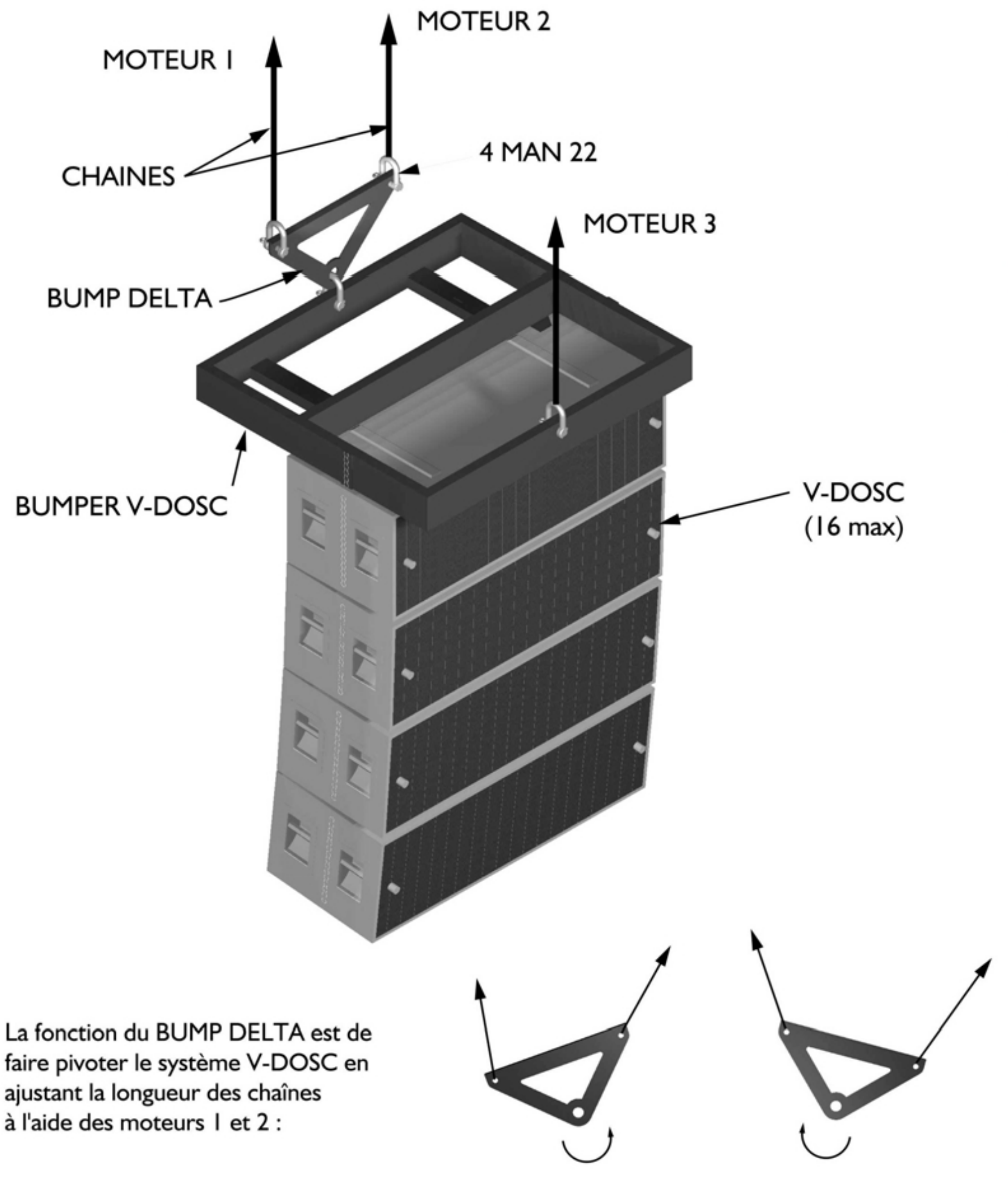
NOTE: Always refer to the mechanical data cells in ARRAY 2000 (see Section 2.3) to verify that safe rigging conditions apply with respect to load distribution .

The BUMPER can also be used for stacking V-DOSC. In this case, the BUMPER is inverted (upside down) and the first element of the array is installed directly on the BUMPER. Since the depth of the BUMPER is larger than that of a single element, this allows for better front-to-rear stability of the

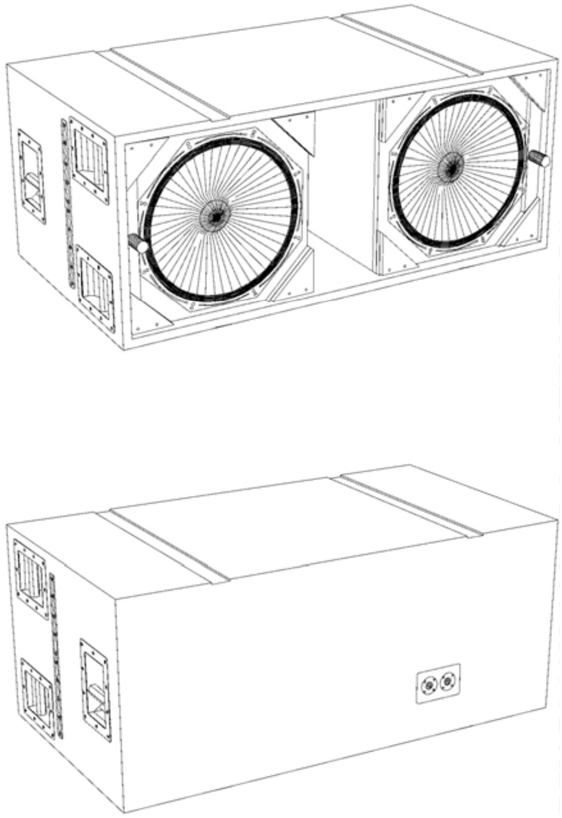
stacked array. Screwjacks can be attached at the four corners of the BUMPER and used to tilt the BUMPER, and hence the whole array. In this manner, the global angle of the array can be adjusted to match coverage requirements. When stacking, angles between adjacent elements cannot be obtained by gravity and SPACERs are employed in addition to ANGLE straps. Alternatively, rear ratchet straps can be employed to provide the correct angle between elements in conjunction with the ANGLE straps.

NOTE: For safety reasons, a stacked array should not exceed more than 6 elements high.

The DELTA PLATE rigging accessory is available to allow for pan adjustment of flown V-DOSC arrays. The relative action of the 2 rear motors controls the rotation of the array as shown in the figure below:



1.4 SB218 SUBWOOFER SPECIFICATIONS



Dimension (WxHxD):	1300mm x 550mm x 700mm (51.2" x 21.7" x 27.6")
Weight:	106 kg (234 lbs)

Figure 8: SB218 Subwoofer – Front and Rear Views

The SB218 subwoofer enclosure has been specifically designed to complement V-DOSC, although it may also be used in other applications. Phase response of the V-DOSC element and the SB218 are compatible throughout the 80-200 Hz region, providing optimum coupling for a wide range of crossover frequencies. With the addition of SB218 subwoofers, the low frequency response of the V-DOSC system is extended down to 25 Hz.

The enclosure is of bass reflex type, with a large-area port enhancing large-signal dynamic capability while minimizing non-linearity due to port turbulence. The SB218 contains 2X 18" drivers (connected in parallel) with a nominal impedance of 4 ohms. Rear panel connection is made via a 4 pin Speakon connector and SUB CABLEs are used for connection to amplifier racks. The SB218 has two side-mounted, vertically-oriented Aeroquip flytrack sections for flying enclosures vertically in a line array configuration as an extension of the V-DOSC array.

1.5 SB218 FLYING BAR

The flying system for constructing an SB218 line array consists of one steel bar, four shackles and two chains incorporating Aeroquip studs. The Aeroquip studs are connected to the Aeroquip flytrack located on each side of the SB218. The flying assembly is rated for up to 8 subwoofer enclosures at a 5:1 safety factor.

Note: when attaching shackles and fittings to the chains it is easier to preattach prior to flying. Lay the chain out flat and remove any twists. Shackles are then attached every 13 chain links, i.e., with a separation of 11 chain links between each shackle.

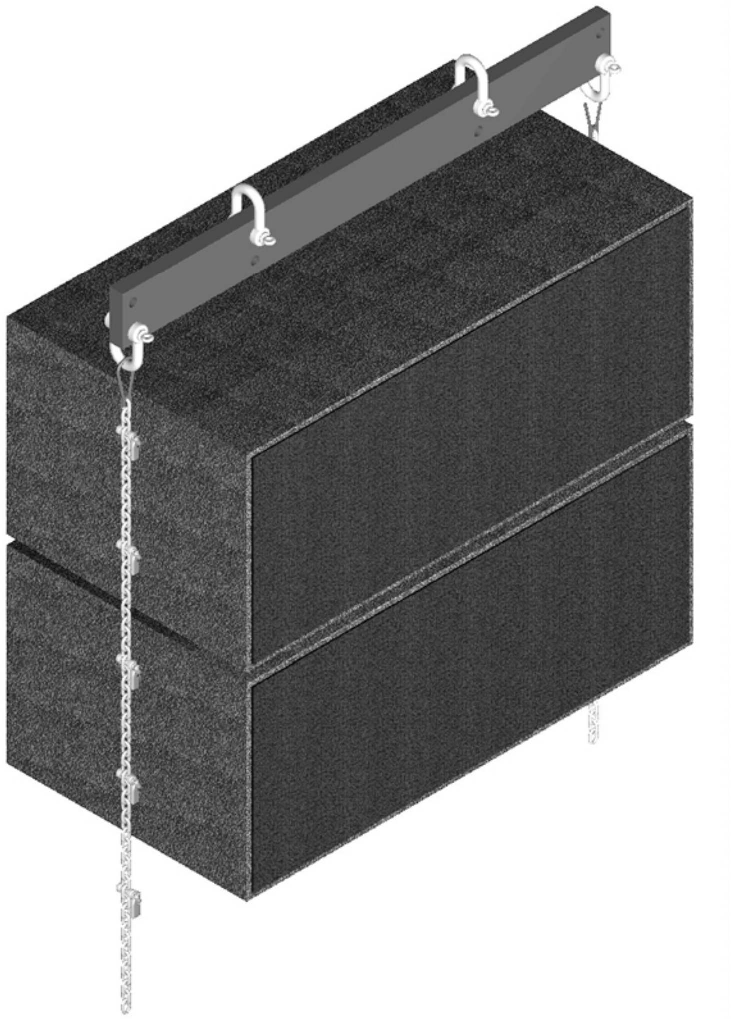


Figure 9: SB218 Flying Bar

1.6 V-DOSC AMPLIFIER RACK

Figure 10: L-ACOUSTICS Amplifier Rack RK12U

The L-ACOUSTICS amplifier rack RK12U is 12 rack units high and contains 4 L-ACOUSTICS LA 48 amplifiers. Overall external dimensions are 77 cm high (including casters) x 61 cm wide x 58 cm deep (30.3 x 26.4 x 22.9 inches). Clearance from the front rack rail to the front of the rack is 9.5 cm (3.7 in). Clearance from the rear rack rail to the rear of the rack is 6 cm (2.4 in). The depth from front to rear rack rails is 42.5 cm (16.7 in) and the depth from front rack rail to the rear support points for the LA 48 amplifier is 39 cm (15.35 in). Due to the switched mode power supply technology employed in the L-ACOUSTICS LA 48, the rack weighs only 98 kg (216 lbs)!

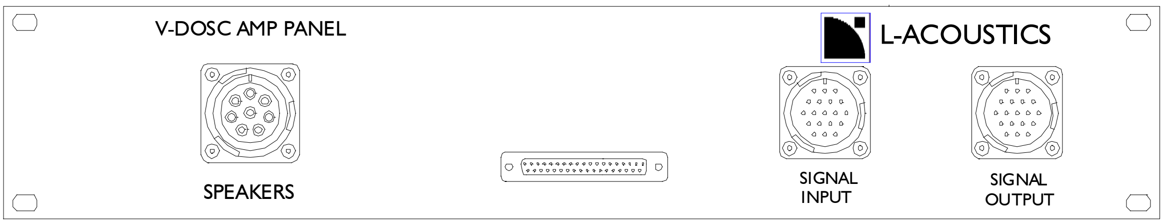
Using the COMB connectors located on the Amp Panel (PAD04), the rack can be configured so that A and B channels are independent. Depending on how the rack is to be configured 2-WAY, 3-WAY or SUB COMB connectors are selected. Essentially, the COMB connectors route the desired input lines from the 19 pin CA-COM connector to the appropriate amplifier inputs for A and B channels, respectively. Using separate COMB connectors for both channels, it is possible to assign the A channels and the B channels independently. Therefore, half an amplifier rack can power up to 3 V-DOSC (6 total), 4 SB218 subwoofers (8 total) or 6 dV-DOSC (12 total).

In terms of construction, the amplifier rack is made of a lightweight aluminum space frame with heavy duty bracing, internal shock mounting, standard rack rails and provision for rear support of amplifiers. Clear, unbreakable polycarbonate (lexan) front and rear doors allow the user to quickly see how the racks are configured and can be conveniently stored inside the rack during use (note: for ventilation purposes, front and rear doors must always be removed during operation). A high impact resistance polyethylene cover provides protection for the rack during transport so that no external case is required. Four recessed Aeroquip flytrack sections are mounted on both sides of the amplifier rack for flown applications.

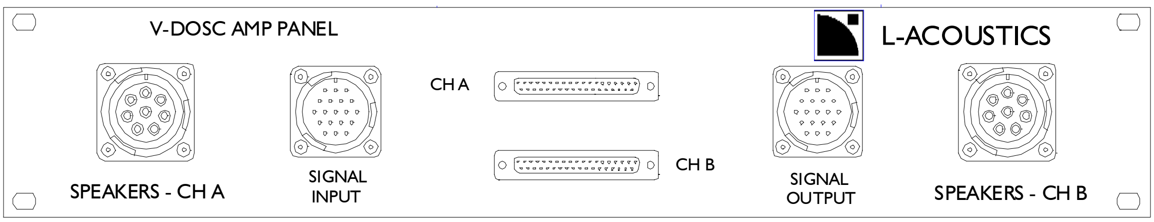
There are recesses in the top cover of each rack that allow racks to be stacked on top of each other with the castors still attached. It is also possible to remove the casters on one amplifier rack, place it on top of a second amp rack and then mechanically bolt the two racks together.

Overall the L-ACOUSTICS amplifier rack provides an extremely efficient package in terms of power versus size and weight while at the same time maintaining flexibility for smaller scale and distributed system applications. Please see the LA 48 specification sheet and user manual for a full description of features.

1.7 V-DOSC AMP PANELS



PAD02 (2 amplifiers per rack)



PAD04 (4 amplifiers per rack)

Figure 11: V-DOSC AMP Panels

The V-DOSC PAD04 amp panel allows for connection of loudspeakers, input signal and output signal loop through. The panel has dual 8 pin female CA-COM connectors for loudspeaker connection and two male 19 pin CA-COM connectors for input signal connection (using either AMP LINK or CROSS LINK cables) and for jumping to subsequent amp racks (using AMP LINK cables). As mentioned above, the COMB connector allows the user to reconfigure the AMP RACK for either 2-way, 3-way or SUB operating modes.

Internally, two sets of 4X male XLR fanouts connect the input signal from the COMB connector on PAD04 to the amplifier inputs. For the CA-COM connector, lines 5 and 6 are always assigned to 2-way fill (high and low, respectively). Line 4 is reserved for subwoofer drive while lines 1, 2 and 3 are for V-DOSC high, mid and low, respectively.

In 3-way mode, 8 pin loudspeaker CA-COM pinouts for channels A and B are as follows: A/B = V-DOSC LOW AMP#3 +/- ; C/D = V-DOSC LOW AMP#4 +/- ; E/F = V-DOSC MID AMP#2 +/- ; G/H = V-DOSC HIGH AMP#1 +/- .

In 2-way mode, 8 pin loudspeaker CA-COM pinouts for channels A and B are as follows: A/B = HF AMP#3 +/- ; C/D = LF AMP#4 +/- ; G/H = HF AMP#1 +/- ; E/F = LF AMP#2 +/- . Either DOFILL or DO2W adapters are used to convert from 8 pin CA-COM to dual Speakon connectors. Individual Speakon pinouts are : +1/-1 = dV-DOSC LF +/- ; +2/-2 = dV-DOSC HF +/-.

For complete details regarding CA-COM line assignments, PAD02 and PAD04 wiring plus COMB connector wiring, please refer to Tables 1 and 2 below.

Table 1: PAD04 Wiring Chart

PAD 04 COMB/PANEL/AMPLIFIER WIRING + CHANNEL ASSIGNMENTS

CA COM 19 WIRING

LINE IN	SIGNAL	CHANNEL	SUB D-37
A	gnd		14
B	+	(HF)	15
C	-		16
D	gnd		17
E	+	(MF)	18
F	-		19
G	gnd		20
H	+	(LF)	21
J	-		22
K	gnd		23
L	+	(SUB)	24
M	-		25
N	gnd		26
P	+	(HF-FILL)	27
R	-		28
S	gnd		29
T	+	(LF-FILL)	30
U	-		31

COMB WIRING / CHANNEL A SUB D-37 TO AMPLIFIER TO SPEAKER CONNECTOR WIRING / AMP CHANNEL ASSIGNMENT

3-WAY	SUB	2-WAY	SUB D-37 A	SIGNAL	XLR COLOR	XLR PIN	AMP CH	AMP OUT	SPEAKON COLOR	CACOM8 A	3-WAY	SUB	2-WAY
14	23	26	1	gnd		1							
15	24	27	2	+	BROWN	2	LA 48 (1)	1+	BLUE	G	HI A	SUB A	HF FILL A
16	25	28	3	-	AMP1 CH A	3	CH A	1-	AMP1 CH A	H			
17	23	29	4	gnd		1							
18	24	30	5	+	VIOLET	2	LA 48 (2)	1+	GREEN	E	MID A	SUB A	LF FILL A
19	25	31	6	-	AMP2 CH A	3	CH A	1-	AMP2 CH A	F			
20	23	26	7	gnd		1							
21	24	27	8	+	WHITE	2	LA 48 (3)	1+	RED	A	LOW1 A	SUB A	HF FILL A
22	25	28	9	-	AMP3 CH A	3	CH A	1-	AMP3 CH A	B			
20	23	29	10	gnd		1							
21	24	30	11	+	ORANGE	2	LA 48 (4)	1+	YELLOW	C	LOW2 A	SUB A	LF FILL A
22	25	31	12	-	AMP4 CH A	3	CH A	1-	AMP4 CH A	D			

COMB WIRING / CHANNEL B SUB D-37 TO AMPLIFIER TO SPEAKER CONNECTOR WIRING / AMP CHANNEL ASSIGNMENT

3-WAY	SUB	2-WAY	SUB D-37 B	SIGNAL	XLR COLOR	XLR PIN	AMP CH	AMP OUT	SPEAKON COLOR	CACOM8 B	3-WAY	SUB	2-WAY
14	23	26	1	gnd	BROWN	1			BLUE				
15	24	27	2	+	+++	2	LA 48 (1)	1+	+++	G	HI B	SUB B	HF FILL B
16	25	28	3	-	AMP1 CH B	3	CH B	1-	AMP1 CH B	H			
17	23	29	4	gnd	VIOLET	1			GREEN				
18	24	30	5	+	+++	2	LA 48 (2)	1+	+++	E	MID B	SUB B	LF FILL B
19	25	31	6	-	AMP2 CH B	3	CH B	1-	AMP2 CH B	F			
20	23	26	7	gnd	WHITE	1			RED				
21	24	27	8	+	+++	2	LA 48 (3)	1+	+++	A	LOW1 B	SUB B	HF FILL B
22	25	28	9	-	AMP3 CH B	3	CH B	1-	AMP3 CH B	B			
20	23	29	10	gnd	ORANGE	1			YELLOW				
21	24	30	11	+	+++	2	LA 48 (4)	1+	+++	C	LOW2 B	SUB B	LF FILL B
22	25	31	12	-	AMP4 CH B	3	CH B	1-	AMP4 CH B	D			

RK12 Amplifier Rack Wiring Diagram for PAD04

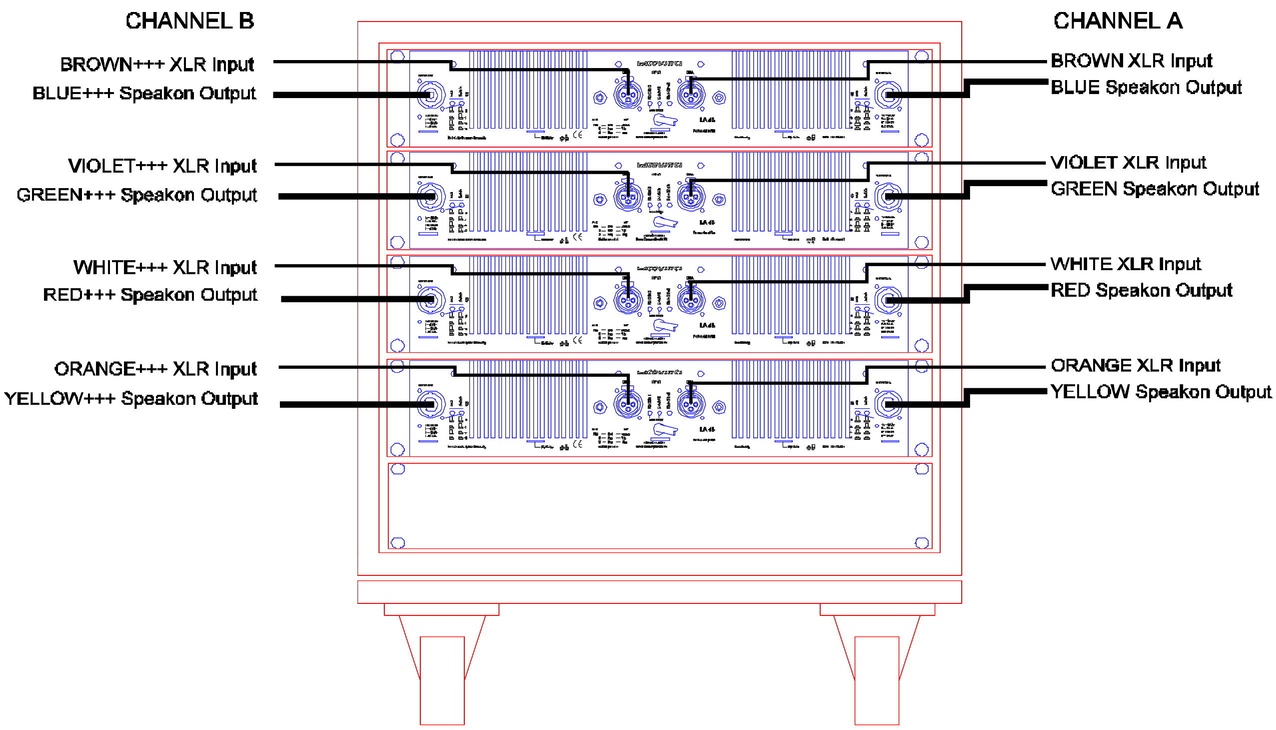


Table 2: PAD02 Wiring Chart

PAD 02 COMB/PANEL/AMPLIFIER WIRING + CHANNEL ASSIGNMENTS

CA COM 19 WIRING

LINE IN	SIGNAL	CHANNEL	SUB D-37
A	gnd		14
B	+	(HF)	15
C	-		16
D	gnd		17
E	+	(MF)	18
F	-		19
G	gnd		20
H	+	(LF)	21
J	-		22
K	gnd		23
L	+	(SUB)	24
M	-		25
N	gnd		26
P	+	(HF-FILL)	27
R	-		28
S	gnd		29
T	+	(LF-FILL)	30
U	-		31

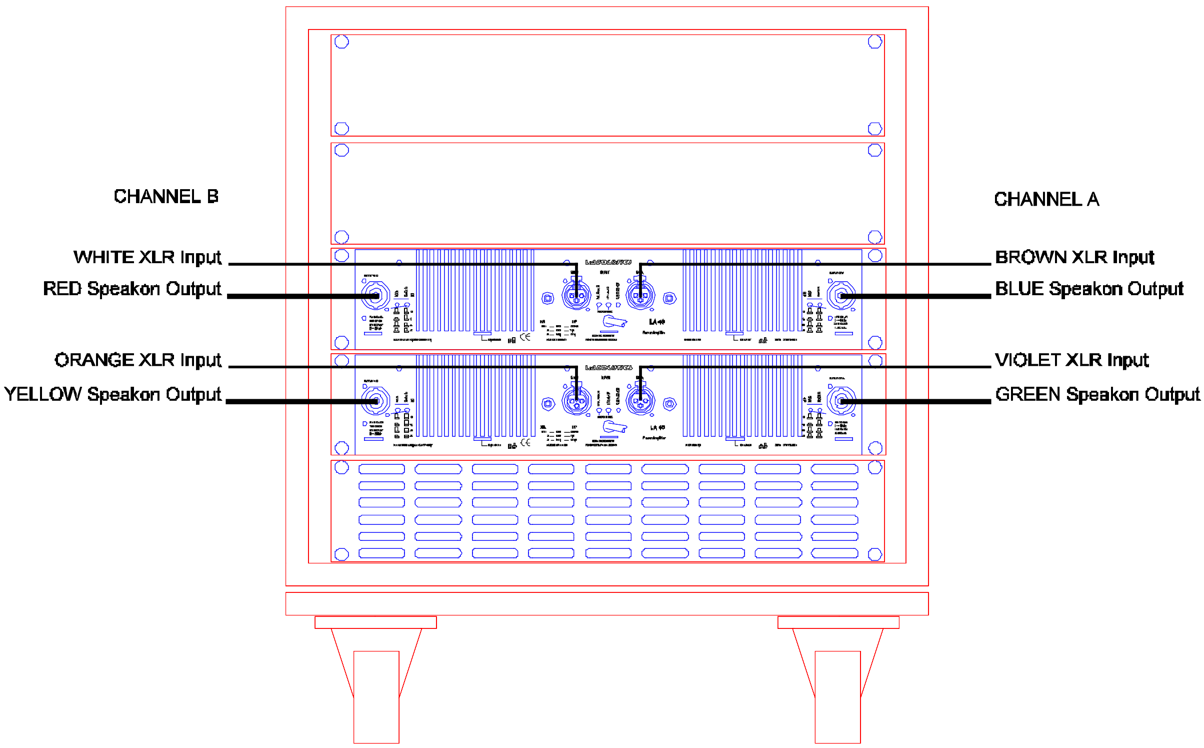
COMB WIRING

3-WAY	SUB	2-WAY
14	23	26
15	24	27
16	25	28
17	23	29
18	24	30
19	25	31
20	23	26
21	24	27
22	25	28
20	23	29
21	24	30
22	25	31

CHANNEL A SUB D-37 TO AMPLIFIER TO SPEAKER CONNECTOR WIRING / **AMP CHANNEL ASSIGNMENT**

SUB D-37 A	SIGNAL	XLR COLOR	XLR PIN	AMP CH	AMP OUT	SPEAKON COLOR	CACOM8	3-WAY	SUB	2-WAY
1	gnd		1							
2	+	BROWN	2	LA 48 (1)	1+	BLUE	G	HI	SUB	HF FILL A
3	-	AMP 1 CH A	3	CH A	1-	AMP 1 CH A	H			
4	gnd		1							
5	+	VIOLET	2	LA 48 (2)	1+	GREEN	E	MID	SUB	LF FILL A
6	-	AMP 2 CH A	3	CH A	1-	AMP 2 CH A	F			
7	gnd		1							
8	+	WHITE	2	LA 48 (1)	1+	RED	A	LOW1	SUB	HF FILL B
9	-	AMP 1 CH B	3	CH B	1-	AMP 1 CH B	B			
10	gnd		1							
11	+	ORANGE	2	LA 48 (2)	1+	YELLOW	C	LOW2	SUB	LF FILL B
12	-	AMP 2 CH B	3	CH B	1-	AMP 2 CH B	D			

RK12-2 Amplifier Rack Wiring Diagram for PAD02



1.8 POWERING V-DOSC

Amplifiers approved for use with V-DOSC include: L-ACOUSTICS LA 48, Lab Gruppen 4000, QSC PowerLight 6.0^{PFC} and CROWN MA-5000VZ. L-ACOUSTICS specifies amplifiers with 32 dB gain as standard. The L-ACOUSTICS RK12U rack contains 4 L-ACOUSTICS LA 48 amplifiers and can power 1+1, 2+2, or 3+3 V-DOSC, 4+4 SB218 subwoofers, 6+6 dV-DOSC or 6+6 ARCS. When powering V-DOSC, 2 enclosures in parallel is the optimum load while 3 is more cost-effective. Powering 3+3 V-DOSC elements is safe for the amplifiers, but does not provide the same standard of sonic quality due to reduced headroom. Powering 4+4 elements from a single amplifier rack is not recommended for normal operation but it is possible to do so in emergency situations.

When powering V-DOSC, 2 amplifier channels power the LF section (since the 15" components are cabled separately), one channel powers the MF and one channel powers the HF. If we consider the four amplifiers in RK12U as numbered 1-4 from top to bottom, nominal impedance loads and amplifier channel assignments when powering a single V-DOSC cabinet are:

- 1 x 16 ohms on high-frequency channel (Amplifier #1 – Channel A).
- 1 x 8 ohms on mid-frequency channel (Amplifier #2 - Channel A)
- 2 x 8 ohms on both low-frequency channels (Amplifiers #3, #4 - Channel A)

When powering subwoofers, each amplifier channel is assigned to one SB218, providing a 4 ohm load. Multiple cabinet impedance loads and power ratings are summarized in Table 3. Recommended amplifier power output ratings are given in Table 4.

Table 3: Load and Power Ratings for V-DOSC

	ONE V-DOSC				TWO V-DOSC				THREE V-DOSC			
SECTION	LOAD	RMS	PEAK	REC'D	LOAD	RMS	PEAK	REC'D	LOAD	RMS	PEAK	REC'D
LOW	8	**375**	1500	750	4	750	3000	1500	2.7	1125	4500	2250
MID	8	**600**	2400	1200	4	1200	4800	2400	2.7	1800	7200	3600
HIGH	16	**200**	800	800	8	400	1600	1600	5.3	600	2400	2400

Table 4: Recommended Power and Amplifier Power Ratings (EIA 1kHz @ 1% THD)

LOAD (ohms)	MAX REC'D	Section (# encl)	MIN REC'D	Section (# encl)	LA 48 nominal	LA 48 peak	CROWN MA5000	CROWN MA5002	QSC 6.0
2					2400	3000	2500	2500	3150
2.7	3600	MF (3)	2250	LF (3)	2250	2600	*2250*	*2250*	*2900*
4	2400	MF (2)	1500	LF (2)	2100	2100	2000	2000	2650
5.3	2400	HF (3)	2400	HF (3)	1900	1900	*1650*	*1650*	*2250*
8	1600	HF (2)	750	LF (1)	1300	1300	1300	1300	1625
16	800	HF (1)	800	HF (1)	650	650	N/A	N/A	N/A

1.9 V-DOSC CONTROL

Four digital signal processing units are currently supported and specified by L-ACOUSTICS for controlling the V-DOSC system: XTA DP 226, DP 224 and BSS FDS 355 (Omnidrive Compact), FDS 366 (Omnidrive Compact Plus).

XTA or BSS processors are supplied with proprietary presets that are intended for specific array configurations. Since the XTA DP 226 is a 2 input by 6 output unit, the DP224 is 2 x 4, the BSS FDS 355 is 3 x 5 and the FDS 366 is 3 x 6, exact internal wiring of your FOH drive rack and digital processor channel assignments will vary depending on the selected processor and the application. Various operating modes, processor channel assignments and MULTI line assignments are described in detail below for the various processors. Carefully consider your flexibility requirements before selecting the number and type of processors to specify.

NOTE: Whichever processor is used, MULTI line assignments must remain standard to allow for system compatibility. Failure to follow MULTI standards may result in damage to speaker components of the V-DOSC system.

ALWAYS REFER TO THE PRESET DESCRIPTION SHEET FOR YOUR PROCESSOR WHEN SELECTING PRESETS AND CONFIGURING THE DRIVE RACK.

a) XTA DP224, DP226 Digital Signal Processors

The XTA DP226 features 2 inputs and 6 outputs while the DP224 is 2 in x 4 out. Both inputs have 8 bands of parametric equalization, system predelay and gain control. All outputs feature crossover filters, 5 band parametric equalizer, high and low shelving filters, channel delay and limiting. Full input/output metering is provided with individual channel mute and access buttons. Single or multiple XTA units can be controlled via PC using XTA's AudioCore windows software. For operational details for either unit please refer to their respective XTA Operating Instruction Manual.

The DP226 can be configured in 5 basic modes: 3x 2-way (left, right and mono sum), stereo 3-way, mono 4-way, mono 5-way and mono 6-way. For 3-way stereo operation, only one XTA processor is required. For 4-way stereo operation, two XTA processors are required. Additional outputs (5 and 6) can then be used for processing of 2-way fill enclosures such as dV-DOSC or ARCS. For mono fill applications, outputs 5 and 6 can be derived from the left+right sum allowing for the operation of two independent mono 2-way fill clusters (e.g. flown center fill plus front fill). For stereo applications, 2-way front- or down-fill systems can be operated using outputs 5 and 6.

The XTA offers independent limiting for each output with attack times that are variable between 0.3 ms to 90 ms. Release times are 4, 8, 16 or 32 times the attack time and thresholds range from +22 dBu to –10 dBu in 1 dB steps. Automatic limiter time constants can be selected where attack and release times are set based on the highpass filter frequency (see the DP224 or DP226 manual). Output meters are linked to the limiter time constants so that "true" output metering is displayed. All displays are relative to the limit threshold, providing a direct indication of available system headroom.

NOTE: XTA treats input memories as separate from program memories (presets). Make sure that when you recall a new preset, all input PEQs and input delays are also reset.

b) BSS FDS 355, FDS 366 Omnidrive Compact Digital Signal Processors

The BSS FDS 355 Omnidrive Compact features 3 inputs and 5 outputs with complete routing flexibility while the FDS 366 is a 3 x 6 unit. Up to fifty bands of parametric equalization are available (depending on the crossover settings) and are assignable to inputs or outputs. All output channels provide crossover filtering, selectable number of parametric eq sections including high and low shelving filters, channel delay, polarity reverse, phase adjustment and limiting. Full metering is provided for all inputs and outputs, with mute and attenuation controls for all outputs. Single or multiple units can be controlled via PC using Soundbench software. Up to 60 internal program locations are available and preset or system software updates can be downloaded via PC card or

from a PC via RS232 ports. Multiple levels of password protection are also available, allowing BSS processors to be configured as a fully secure unit. For exact details regarding operation, please refer to the appropriate BSS Operating Instruction Manual.

BSS output channel limiters can be set to fast, medium or slow (366) or normal/fast (355), depending on the desired attack and release times. Limiter detection circuitry is centered on the mid frequency for each band and threshold units of either dBu or mV can be selected. Limiters can also be disabled – in this case, the red OVER indicator is illuminated on the disabled channel to serve as a warning. Even when limiters are disabled, the threshold setting determines the output meter sensitivity, i.e., the yellow limit indicator on the display corresponds to the limiter threshold.

c) General Guidelines Regarding System Protection

As supplied by L-ACOUSTICS, limit thresholds for both XTA and BSS Processors are initially set at +9, +9, +9 and +9 dBu for sub, low, mid and high channels, respectively. These thresholds are matched to the input sensitivity of the L-ACOUSTICS LA 48 (+9.5 dBu) so that system protection is performed by a combination of the limiting circuits of both amplifier and digital signal processor.

NOTE: For the CROWN MA-5000VZ in the 1.4 Vrms input sensitivity setting (not recommended since this corresponds to 36 dB gain), this is equivalent to +5.1 dBu so limiter thresholds must be lowered. It is highly recommended that users modify their CROWN MA-5000VZ amplifiers to 32 dB gain in accordance with the V-DOSC Network Standard. Apart from limiter calibration issues, gain structure differences become an issue when using a mixture of LA 48 and MA-5000 amplifiers within the same system if all amplifiers are not at 32 dB standard gain.

XTA and BSS limiter thresholds are user accessible and should be set at +9 dBu (for LA 48) or +5 dBu (for CROWN in the 1.4 Vrms setting) for all bands. Exact settings will depend on individual engineer preferences and the type of music or application which, in turn, determines how hard the V-DOSC system is being operated. When additional crossover limiting is desirable, limit thresholds can be set 1to 3 dBu below the amplifier input sensitivity. This further prevents transients from driving the amplifier into clipping which can result in speaker damage.

NOTE: Setting limit thresholds to the amplifier input sensitivity is important since this calibrates the output meter display of the crossover to correspond to the amplifier clip point. This gives the system operator a direct visual indication as to how hard the system is being operated.

The L-ACOUSTICS LA 48 is an excellent power match for the V-DOSC system and the LA 48 clip limiter is sonically very transparent. The LA 48 clip limiter works by monitoring the output and comparing the distortion produced between the input and output of the amplifier. If the distortion exceeds 1% THD for any reason (voltage or current clipping), the limiter reduces the input signal proportionally (2 msec attack, 150 msec release). Under normal operation, LA 48 clip limiting is inaudible and L-ACOUSTICS recommends leaving the Channel A and B clip limiters switched "on" (rear panel button depressed) at all times.

NOTE: The LA48 has a comparatively low input sensitivity (9.5 dBu) versus the Crown 5000 (5 dBu in the 1.4 Vrms setting). This means that, in practice, it can be necessary to equally scale up the individual crossover channel output gains in order to have sufficient drive capability (note: this has been done for Version 5 preset library release - see section 1.10 b for details). It is far better to use the output drive capability of the processor DACs and analog output section rather than overdrive the input ADCs so do not be afraid to increase the channel output gains in order to achieve a comfortable gain structure. This will also depend on how "hot or cold" the FOH mix engineer likes to run his console. When in doubt, disconnect all loudspeaker cables and run pink noise from the console at nominal level through the crossover to the power amplifiers and examine crossover input/output levels, crossover limiter indicators and amp clip indicators to verify system protection and gain structure.

Table 5: Approved Amplifier Input Sensitivities

L-ACOUSTICS LA 48	9.5 dBu (32 dB gain setting)
LAB GRUPPEN 4000	9.5 dBu (32 dB gain setting)
CROWN MA-5000VZ	9.2 dBu (modified for 32 dB gain - recommended) 5.1 dBu (1.4 Vrms input sensitivity setting)
QSC POWERLITE 6.0	10.2 dBu (32 dB gain)

Once set, it is possible to lock out limit thresholds for both BSS and XTA processors using the OWNER LOCK feature then storing the preset to another memory location.

1.10 V-DOSC PRESET SELECTION

a) V-DOSC Preset Policy

V-DOSC presets are intended to be used as a reference for all Qualified V-DOSC Technicians and Certified V-DOSC Engineers. According to L-ACOUSTICS company policy, key parameters are software protected and preset data is not freely communicated in order to preserve quality control, confidentiality and to maintain the integrity of L-ACOUSTICS system presets.

A lot of engineering and real world testing goes into determining optimum V-DOSC presets – detailed polar measurements and weighted spatial averaging are used to determine component equalization, crossover points and crossover filter slopes, for example. As a result, V-DOSC presets give the user an optimum starting point – system tuning should be done using band attenuation, accurate subwoofer time alignment and system equalization – not by altering crossover presets for the following reason:

Without proper instrumentation and spatial averaging, adjustments made at one location (e.g. the mix position) are not optimum at all other locations within the defined coverage region of the system. When made by ear, such adjustments are often misguided – the user may be in a local room mode (low frequency pressure maximum or minimum) and/or may be hearing a cancellation or addition due to crossover misalignment that sounds good at that specific location but what about all others? Meanwhile, the same result could have been achieved while preserving the power response of the system (and satisfaction of WST criteria) by using the correct crossover preset and a simple equalization cut or correct time alignment of subwoofers …

The bottom line is that making sure that V-DOSC is used properly is in **everyone's** best interest and it is up to the Qualified V-DOSC Technician and Certified V-DOSC Engineer to maintain quality control standards. Quality control starts with good sound design, proper array design, accurate installation, correct preset selection and a solid methodology for system tuning. Restricting access to presets is in no way meant to restrict the creative process – on the contrary, the overall systems approach is intended to enhance it by ensuring quality control and repeatability.

In practice, all presets are distributed to end users via PCMCIA Card so that the presets remain software protected. Presets and preset updates are available directly from L-ACOUSTICS headquarters in France or from Cox Audio Engineering in the U.S. L-ACOUSTICS maintains a library of stock presets for both XTA and BSS processors to support approved amplifiers for a variety of operating modes and cabinet combinations. Custom presets are available on a special order basis and there is a standard price per preset in order to cover custom engineering costs.

b) General Description of V-DOSC Presets

The selection of one preset over another depends on many parameters including the array configuration, musical program and personal taste of the sound engineer. In general terms, "LO"

presets are the "smoothest" while "HI" presets are "brighter" (LO and HI refer to differences in the amount of HF shelving equalization applied to the high channel).

Whenever there is an "X" in the preset name, something is extended. For V-DOSC X presets, the sub LPF is extended higher and the low HPF is extended lower (the operating bandwidth for both sections is 27 - 200 Hz). For X presets the subwoofers are intended to work in combination with the low section of the main V-DOSC array in 4-way mode when the subwoofers are physically very close to the V-DOSC array and act as a low frequency eXtension of the system.

For 4W presets, the subwoofer channel is low pass filtered at 80 Hz and the V-DOSC low channel is high pass filtered at 80 Hz. Although 4W presets do not utilize the full potential of the V-DOSC low section in producing maximum low frequency output, in some cases 4W programs may provide mix engineers with a more traditional 4-way system that is more familiar to them.

For 3-way stereo V-DOSC 3WX presets, the low HPF is extended to 40 Hz and shelving eq is introduced. Note: either V-DOSC 3W (50 Hz HPF) or V-DOSC 3WX presets should be useful in conjunction with separate AUX drive processing for the sub section.

To summarize the main differences in low section processing for V-DOSC presets:

PRESET	Low Section HPF
X	27 Hz (LR24)
4W	80 Hz (LR24)
3W	50 Hz (LR24)
3WX	40 Hz (BW12 + shelving eq)

The Version 6 preset release has been optimized for a 1.5 : 1 cabinet ratio of V-DOSC : SB218 (for example, 3:2, 6:4, 9:6, 12:8, 15:10). Recommended gain scaling procedures for different cabinet ratios are summarized as follows:

V-DOSC:SB218 Cabinet Ratio	SUB Output Gain	LOW Output Gain	
2:1	+6 dB	0 dB	
1.5:1	+4 dB	0 dB	<- recommended ratio, standard scaling
1:1	+4 dB	+4 dB	

Following this gain scaling procedure according to cabinet ratio will provide the same low end spectral contour for V-DOSC 4W and X presets. The mid and high sections should then be scaled up/down equally according to the size of the array in order to compensate for low frequency coupling effects and provide the overall desired tonal balance (see Chapter 5 re: tuning). As a starting point, output channel gains for a 1.5:1 V-DOSC:SB218 cabinet ratio are: sub +4, low 0, mid -5, high -5.

Version 5 preset names and descriptions for BSS 355, 366 and XTA 224, 226 processors are given in Tables 6, 7, 8 and 9, respectively. Full details of channel assignments and user adjustable parameters are provided in the Preset Description sheets that are distributed with the processor PCMCIA cards.

b) BSS FDS 355 VERSION 6 0801 PRESETS FOR V-DOSC

BSS FDS 355 VERSION V6 0801 PRESETS

PRESET NAME	PGM TYPE	Mem	OUT 1 (Source)	OUT 2 (Source)	OUT 3 (Source)	OUT 4 (Source)	OUT 5 (Source)
USER		1					
VD X LO	4(A)+1(B)	2	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	SUB (B)
VD X HI	4(A)+1(B)	3	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	SUB (B)
VD 4W LO	4(A)+1(B)	4	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	SUB (B)
VD 4W HI	4(A)+1(B)	5	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	SUB (B)
VD DV X LO	3(A)+2(B)	6	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)
VD DV X HI	3(A)+2(B)	7	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)
VD DV 4W LO	3(A)+2(B)	8	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)
VD DV 4W HI	3(A)+2(B)	9	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)
VD ARC X LO	3(A)+2(B)	10	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	ARCS LO (B)	ARCS HI (B)
VD ARC X HI	3(A)+2(B)	11	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	ARCS LO (B)	ARCS HI (B)
VD ARC 4WL	3(A)+2(B)	12	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	ARCS LO (B)	ARCS HI (B)
VD ARC 4WH	3(A)+2(B)	13	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	ARCS LO (B)	ARCS HI (B)
VD FR X LO	3(A)+2(B)	14	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	FULLRANGE (B)	FULLRANGE (B)
VD FR X HI	3(A)+2(B)	15	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	FULLRANGE (B)	FULLRANGE (B)
VD FR 4WL	3(A)+2(B)	16	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	FULLRANGE (B)	FULLRANGE (B)
VD FR 4WH	3(A)+2(B)	17	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	FULLRANGE (B)	FULLRANGE (B)
DV 2W LO	mono+2(A)+2(B)	18	SUM (A+B)	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)
DV 2W HI	mono+2(A)+2(B)	19	SUM (A+B)	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)
DV 2WX LO	mono+2(A)+2(B)	20	SUM (A+B)	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)
DV 2WX HI	mono+2(A)+2(B)	21	SUM (A+B)	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)
DV 3W 200 L	mono+2(A)+2(B)	22	MONO dV-SUB (A+B)	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)
DV 3W 200 H	mono+2(A)+2(B)	23	MONO dV-SUB (A+B)	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)
DV 3W 120 L	mono+2(A)+2(B)	24	MONO dV-SUB (A+B)	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)
DV 3W 120 H	mono+2(A)+2(B)	25	MONO dV-SUB (A+B)	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)
DV 3W 80 L	mono+2(A)+2(B)	26	MONO dV-SUB (A+B)	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)
DV 3W 80 H	mono+2(A)+2(B)	27	MONO dV-SUB (A+B)	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)
DV 3W SB L	mono+2(A)+2(B)	28	MONO SB218 (A+B)	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)
DV 3W SB H	mono+2(A)+2(B)	29	MONO SB218 (A+B)	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)
DV 3WX SB L	mono+2(A)+2(B)	30	MONO SB218 (A+B)	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)
DV 3WX SB H	mono+2(A)+2(B)	31	MONO SB218 (A+B)	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)
DV 4W DVS L	4(A)+1(B)	32	dV-SUB ground (A)	dV-SUB flown (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-SUB ground (B)
DV 4W DVS H	4(A)+1(B)	33	dV-SUB ground (A)	dV-SUB flown (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-SUB ground (B)
DV 4W SB L	4(A)+1(B)	34	SB218 ground (A)	dV-SUB flown (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	SB218 ground (B)
DV 4W SB H	4(A)+1(B)	35	SB218 ground (A)	dV-SUB flown (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	SB218 ground (B)
ARCS 2W LO	mono+2(A)+2(B)	36	SUM (A+B)	ARCS LO (A)	ARCS HI (A)	ARCS LO (B)	ARCS HI (B)
ARCS 2W HI	mono+2(A)+2(B)	37	SUM (A+B)	ARCS LO (A)	ARCS HI (A)	ARCS LO (B)	ARCS HI (B)
ARC 3W SB L	mono+2(A)+2(B)	38	MONO SB218 (A+B)	ARCS LO (A)	ARCS HI (A)	ARCS LO (B)	ARCS HI (B)
ARC 3W SB H	mono+2(A)+2(B)	39	MONO SB218 (A+B)	ARCS LO (A)	ARCS HI (A)	ARCS LO (B)	ARCS HI (B)
ARC 3W DV L	mono+2(A)+2(B)	40	MONO dV-SUB (A+B)	ARCS LO (A)	ARCS HI (A)	ARCS LO (B)	ARCS HI (B)
ARC 3W DV H	mono+2(A)+2(B)	41	MONO dV-SUB (A+B)	ARCS LO (A)	ARCS HI (A)	ARCS LO (B)	ARCS HI (B)
SUB ARC	5-WAY (A)	42	DELAY1 (A)	DELAY 2 (A)	DELAY 3 (A)	DELAY 4 (A)	DELAY 5 (A)

Table 6: BSS FDS 355 Presets

c) BSS FDS 366 VERSION 6 0801 PRESETS FOR V-DOSC

BSS FDS 366 VERSION V6 0801 PRESETS

PRESET NAME	PGM TYPE	Mem	OUT 1 (Source)	OUT 2 (Source)	OUT 3 (Source)	OUT 4 (Source)	OUT 5 (Source)	OUT 6 (Source)
USER	3(A)+3(B)	1						
VD X LO	5(A)+1(B)	2	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	FULL (A)	SUB (B)
VD X HI	5(A)+1(B)	3	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	FULL (A)	SUB (B)
VD 4W LO	5(A)+1(B)	4	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	FULL (A)	SUB (B)
VD 4W HI	5(A)+1(B)	5	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	FULL (A)	SUB (B)
VD DV X LO	4(A)+2(B)	6	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)
VD DV X HI	4(A)+2(B)	7	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)
VD DV4W LO	4(A)+2(B)	8	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)
VD DV 4W HI	4(A)+2(B)	9	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)
VD ARC X LO	4(A)+2(B)	10	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	ARCS LO (B)	ARCS HI (B)
VD ARC X H	4(A)+2(B)	11	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	ARCS LO (B)	ARCS HI (B)
VD ARC 4W L	4(A)+2(B)	12	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	ARCS LO (B)	ARCS HI (B)
VD ARC 4W H	4(A)+2(B)	13	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	ARCS LO (B)	ARCS HI (B)
VD FR X LO	4(A)+2(B)	14	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	FULLRANGE (B)	FULLRANGE (B)
VD FR X HI	4(A)+2(B)	15	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	FULLRANGE (B)	FULLRANGE (B)
VD FR4W LO	4(A)+2(B)	16	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	FULLRANGE (B)	FULLRANGE (B)
VD FR4W HI	4(A)+2(B)	17	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	FULLRANGE (B)	FULLRANGE (B)
VD 3W LO	3(A)+3(B)	18	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	V-DOSC LO (B)	V-DOSC MID (B)	V-DOSC HI (B)
VD 3W HI	3(A)+3(B)	19	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	V-DOSC LO (B)	V-DOSC MID (B)	V-DOSC HI (B)
VD 3WX LO	3(A)+3(B)	20	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	V-DOSC LO (B)	V-DOSC MID (B)	V-DOSC HI (B)
VD 3WX HI	3(A)+3(B)	21	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	V-DOSC LO (B)	V-DOSC MID (B)	V-DOSC HI (B)
DV 2W LO	2(A)+2(B)+2(C)	22	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)	dV-DOSC LO (C)	dV-DOSC HI (C)
DV 2W HI	2(A)+2(B)+2(C)	23	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)	dV-DOSC LO (C)	dV-DOSC HI (C)
DV 2WX LO	2(A)+2(B)+2(C)	24	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)	dV-DOSC LO (C)	dV-DOSC HI (C)
DV 2WX HI	2(A)+2(B)+2(C)	25	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)	dV-DOSC LO (C)	dV-DOSC HI (C)
DV 3W200 L	3(A)+3(B)	26	dV-SUB (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-SUB (B)	dV-DOSC LO (B)	dV-DOSC HI (B)
DV 3W200 H	3(A)+3(B)	27	dV-SUB (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-SUB (B)	dV-DOSC LO (B)	dV-DOSC HI (B)
DV 3W120 L	3(A)+3(B)	28	dV-SUB (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-SUB (B)	dV-DOSC LO (B)	dV-DOSC HI (B)
DV 3W120 H	3(A)+3(B)	29	dV-SUB (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-SUB (B)	dV-DOSC LO (B)	dV-DOSC HI (B)
DV 3W80 L	3(A)+3(B)	30	dV-SUB (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-SUB (B)	dV-DOSC LO (B)	dV-DOSC HI (B)
DV 3W80 H	3(A)+3(B)	31	dV-SUB (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-SUB (B)	dV-DOSC LO (B)	dV-DOSC HI (B)
DV 3W SB L	3(A)+3(B)	32	SB218 SUB (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	SB218 SUB (B)	dV-DOSC LO (B)	dV-DOSC HI (B)
DV 3W SB H	3(A)+3(B)	33	SB218 SUB (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	SB218 SUB (B)	dV-DOSC LO (B)	dV-DOSC HI (B)
DV 3WX SB L	3(A)+3(B)	34	SB218 SUB (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	SB218 SUB (B)	dV-DOSC LO (B)	dV-DOSC HI (B)
DV 3WX SB H	3(A)+3(B)	35	SB218 SUB (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	SB218 SUB (B)	dV-DOSC LO (B)	dV-DOSC HI (B)
DV 4W DVS L	5(A)+1(B)	36	dV-SUB ground (A)	dV-SUB flown (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	FULL (A)	dV-SUB ground (B)
DV 4W DVS H	5(A)+1(B)	37	dV-SUB ground (A)	dV-SUB flown (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	FULL (A)	dV-SUB ground (B)
DV 4W SB L	5(A)+1(B)	38	SB218 ground (A)	dV-SUB flown (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	FULL (A)	SB218 ground (B)
DV 4W SB H	5(A)+1(B)	39	SB218 ground (A)	dV-SUB flown (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	FULL (A)	SB218 ground (B)
ARCS 2W LO	2(A)+2(B)+2(C)	40	ARCS LO (A)	ARCS HI (A)	ARCS LO (B)	ARCS HI (B)	ARCS LO (C)	ARCS HI (C)
ARCS 2W HI	2(A)+2(B)+2(C)	41	ARCS LO (A)	ARCS HI (A)	ARCS LO (B)	ARCS HI (B)	ARCS LO (C)	ARCS HI (C)
ARC 3W SB L	3(A)+3(B)	42	SB218 SUB (A)	ARCS LO (A)	ARCS HI (A)	SB218 SUB (B)	ARCS LO (B)	ARCS HI (B)
ARC 3W SB H	3(A)+3(B)	43	SB218 SUB (A)	ARCS LO (A)	ARCS HI (A)	SB218 SUB (B)	ARCS LO (B)	ARCS HI (B)
ARC 3W DV L	3(A)+3(B)	44	dV-SUB SUB (A)	ARCS LO (A)	ARCS HI (A)	dV-SUB SUB (B)	ARCS LO (B)	ARCS HI (B)
ARC 3W DV H	3(A)+3(B)	45	dV-SUB SUB (A)	ARCS LO (A)	ARCS HI (A)	dV-SUB SUB (B)	ARCS LO (B)	ARCS HI (B)
SUB ARC	6-way (A)	46	SB218 SUB (A) T1	SB218 SUB (A) T2	SB218 SUB (A) T3	SB218 SUB (A) T4	SB218 SUB (A) T5	SB218 SUB (A) T6

Table 7: BSS FDS 366 Presets

d) XTA DP224 VERSION 6 0801 PRESETS FOR V-DOSC

XTA DP 224 VERSION V6 0801 PRESETS

PRESET NAME	PGM TYPE	MEM	OUT 1 (Source)	OUT 2 (Source)	OUT 3 (Source)	OUT 4 (Source)
V-DOSC X LO	4-way (A)	10	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)
V-DOSC X HI	4-way (A)	11	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)
V-DOSC 4W LO	4-way (A)	12	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)
V-DOSC 4W HI	4-way (A)	13	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)
V-DOSC X LO AUX	3-way (A) + SUB (B)	14	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	SUB (B)
V-DOSC X HI AUX	3-way (A) + SUB (B)	15	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	SUB (B)
V-DOSC 4W LO AUX	3-way (A) + SUB (B)	16	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	SUB (B)
V-DOSC 4W HI AUX	3-way (A) + SUB (B)	17	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	SUB (B)
dV-DOSC 2W 100 LO	2-way (A) + 2-way(B)	18	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)
dV-DOSC 2W 100 HI	2-way (A) + 2-way(B)	19	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)
dV-DOSC 2W 75 LO	2-way (A) + 2-way(B)	20	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)
dV-DOSC 2W 75 HI	2-way (A) + 2-way(B)	21	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)
dV 3W 200 dVS LO	3-way (A) + SUB (B)	22	dV-SUB (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-SUB (B)
dV 3W 200 dVS HI	3-way (A) + SUB (B)	23	dV-SUB (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-SUB (B)
dV 3W 120 dVS LO	3-way (A) + SUB (B)	24	dV-SUB (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-SUB (B)
dV 3W 120 dVS HI	3-way (A) + SUB (B)	25	dV-SUB (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-SUB (B)
dV 3W 80 dVS LO	3-way (A) + SUB (B)	26	dV-SUB (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-SUB (B)
dV 3W 80 dVS HI	3-way (A) + SUB (B)	27	dV-SUB (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-SUB (B)
dV 3W SB218 LO	3-way (A) + SUB (B)	28	SB218 (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	SB218 (B)
dV 3W SB218 HI	3-way (A) + SUB (B)	29	SB218 (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	SB218 (B)
dV 3WX SB218 LO	3-way (A) + SUB (B)	30	SB218 (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	SB218 (B)
dV 3WX SB218 HI	3-way (A) + SUB (B)	31	SB218 (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	SB218 (B)
dV 4W dV-SUB LO	4-way (A)	32	dV-SUB Ground (A)	dV-SUB Flown (A)	dV-DOSC LOW (A)	dV-DOSC HIGH (A)
dV 4W dV-SUB HI	4-way (A)	33	dV-SUB Ground (A)	dV-SUB Flown (A)	dV-DOSC LOW (A)	dV-DOSC HIGH (A)
dV 4W SB218 LO	4-way (A)	34	SB218 Ground (A)	dV-SUB Flown (A)	dV-DOSC LOW (A)	dV-DOSC HIGH (A)
dV 4W SB218 HI	4-way (A)	35	SB218 Ground (A)	dV-SUB Flown (A)	dV-DOSC LOW (A)	dV-DOSC HIGH (A)
dV dVS LO dVS AUX	3-way (A) + SUB (B)	36	dV-SUB Flown (A)	dV-DOSC LOW (A)	dV-DOSC HIGH (A)	dV-SUB Ground (B)
dV dVS HI dVS AUX	3-way (A) + SUB (B)	37	dV-SUB Flown (A)	dV-DOSC LOW (A)	dV-DOSC HIGH (A)	dV-SUB Ground (B)
dV dVS LO SB AUX	3-way (A) + SUB (B)	38	dV-SUB Flown (A)	dV-DOSC LOW (A)	dV-DOSC HIGH (A)	SB218 Ground (B)
dV dVS HI SB AUX	3-way (A) + SUB (B)	39	dV-SUB Flown (A)	dV-DOSC LOW (A)	dV-DOSC HIGH (A)	SB218 Ground (B)
ARCS 2W LO	2-way (A) + 2-way(B)	40	ARCS LO (A)	ARCS HI (A)	ARCS LO (B)	ARCS HI (B)
ARCS 2W HI	2-way (A) + 2-way(B)	41	ARCS LO (A)	ARCS HI (A)	ARCS LO (B)	ARCS HI (B)
ARCS 3W SB218 LO	3-way (A) + SUB (B)	42	SB218 SUB (A)	ARCS LO (A)	ARCS HI (A)	SB218 SUB (B)
ARCS 3W SB218 HI	3-way (A) + SUB (B)	43	SB218 SUB (A)	ARCS LO (A)	ARCS HI (A)	SB218 SUB (B)
ARCS 3W dVSUB LO	3-way (A) + SUB (B)	44	dV-SUB SUB (A)	ARCS LO (A)	ARCS HI (A)	dV-SUB SUB (B)
ARCS 3W dVSUB HI	3-way (A) + SUB (B)	45	dV-SUB SUB (A)	ARCS LO (A)	ARCS HI (A)	dV-SUB SUB (B)
115FM 2W	2-way (A) + 2-way(B)	46	115FM LO (A)	115FM HI (A)	115FM LO (B)	115FM HI (B)
115FM 2WX	2-way (A) + 2-way(B)	47	115FM LO (A)	115FM HI (A)	115FM LO (B)	115FM HI (B)
115FM 3W SB218	3-way (A) + SUB (B)	48	SB218 SUB (A)	115FM LO (A)	115FM HI (A)	SB218 SUB (B)

Table 8 : XTA DP224 Presets

e) XTA DP226 VERSION 6 0801 PRESETS FOR V-DOSC

XTA DP226 VERSION V6 0801 PRESETS

PRESET NAME	PGM TYPE	MEM	OUT 1 (Source)	OUT 2 (Source)	OUT 3 (Source)	OUT 4 (Source)	OUT 5 (Source)	OUT 6 (Source)
V-DOSC X LO	5-way (A) + 1 (B)	10	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	FULL (A)	SUB (B)
V-DOSC X HI	5-way (A) + 1 (B)	11	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	FULL (A)	SUB (B)
V-DOSC 4W LO	5-way (A) + 1 (B)	12	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	FULL (A)	SUB (B)
V-DOSC 4W HI	5-way (A) + 1 (B)	13	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	FULL (A)	SUB (B)
V-DOSC+dV X LO	4-way (A) + 2 (B)	14	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)
V-DOSC+dV X HI	4-way (A) + 2 (B)	15	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)
V-DOSC+dV 4W LO	4-way (A) + 2 (B)	16	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)
V-DOSC+dV 4W HI	4-way (A) + 2 (B)	17	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)
V-DOSC+ARCS X LO	4-way (A) + 2 (B)	18	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	ARCS LO (B)	ARCS HI (B)
V-DOSC+ARCS X HI	4-way (A) + 2 (B)	19	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	ARCS LO (B)	ARCS HI (B)
V-DOSC+ARCS 4W LO	4-way (A) + 2 (B)	20	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	ARCS LO (B)	ARCS HI (B)
V-DOSC+ARCS 4W HI	4-way (A) + 2 (B)	21	SB218 SUB (A)	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	ARCS LO (B)	ARCS HI (B)
V-DOSC+dV LOAUX	5-way (A) + 1 (B)	22	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	SUB (B)
V-DOSC+dV HIAUX	5-way (A) + 1 (B)	23	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	SUB (B)
V-DOSC+ARCS LOAUX	5-way (A) + 1 (B)	24	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	ARCS LO (A)	ARCS HI (A)	SUB (B)
V-DOSC+ARCS HIAUX	5-way (A) + 1 (B)	25	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	ARCS LO (A)	ARCS HI (A)	SUB (B)
V-DOSC 3W LO	3-way stereo	26	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	V-DOSC LO (B)	V-DOSC MID (B)	V-DOSC HI (B)
V-DOSC 3W HI	3-way stereo	27	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	V-DOSC LO (B)	V-DOSC MID (B)	V-DOSC HI (B)
V-DOSC 3WX LO	3-way stereo	28	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	V-DOSC LO (B)	V-DOSC MID (B)	V-DOSC HI (B)
V-DOSC 3WX HI	3-way stereo	29	V-DOSC LO (A)	V-DOSC MID (A)	V-DOSC HI (A)	V-DOSC LO (B)	V-DOSC MID (B)	V-DOSC HI (B)
dV-DOSC 2W 100 LO	2-way stereo + mono sum (5/6)	30	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)	FULL (A+B)	FULL (A+B)
dV-DOSC 2W 100 HI	2-way stereo + mono sum (5/6)	31	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)	FULL (A+B)	FULL (A+B)
dV-DOSC 2W 75 LO	2-way stereo + mono sum (5/6)	32	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)	FULL (A+B)	FULL (A+B)
dV-DOSC 2W 75 HI	2-way stereo + mono sum (5/6)	33	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-DOSC LO (B)	dV-DOSC HI (B)	FULL (A+B)	FULL (A+B)
dV 3W 120 dVS LO	3-way stereo	34	dV-SUB (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-SUB (B)	dV-DOSC LO (B)	dV-DOSC HI (B)
dV 3W 120 dVS HI	3-way stereo	35	dV-SUB (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-SUB (B)	dV-DOSC LO (B)	dV-DOSC HI (B)
dV 3W 80 dVS LO	3-way stereo	36	dV-SUB (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-SUB (B)	dV-DOSC LO (B)	dV-DOSC HI (B)
dV 3W 80 dVS HI	3-way stereo	37	dV-SUB (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	dV-SUB (B)	dV-DOSC LO (B)	dV-DOSC HI (B)
dV 3W SB218 LO	3-way stereo	38	SB218 SUB (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	SB218 SUB (B)	dV-DOSC LO (B)	dV-DOSC HI (B)
dV 3W SB218 HI	3-way stereo	39	SB218 SUB (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	SB218 SUB (B)	dV-DOSC LO (B)	dV-DOSC HI (B)
dV 4W dV-SUB LO	5-way (A) + 1 (B)	40	dV-SUB Ground (A)	dV-SUB Flown (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	FULL (A)	dV-SUB Ground (B)
dV 4W dV-SUB HI	5-way (A) + 1 (B)	41	dV-SUB Ground (A)	dV-SUB Flown (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	FULL (A)	dV-SUB Ground (B)
dV 4W SB218 LO	5-way (A) + 1 (B)	42	SB218 Ground (A)	dV-SUB Flown (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	FULL (A)	SB218 Ground (B)
dV 4W SB218 HI	5-way (A) + 1 (B)	43	SB218 Ground (A)	dV-SUB Flown (A)	dV-DOSC LO (A)	dV-DOSC HI (A)	FULL (A)	SB218 Ground (B)
ARCS 2W LO	2-way stereo + mono sum (5/6)	44	ARCS LO (A)	ARCS HI (A)	ARCS LO (B)	ARCS HI (B)	FULL (A+B)	FULL (A+B)
ARCS 2W HI	2-way stereo + mono sum (5/6)	45	ARCS LO (A)	ARCS HI (A)	ARCS LO (B)	ARCS HI (B)	FULL (A+B)	FULL (A+B)
ARCS 3W SB218 LO	3-way stereo	46	SB218 SUB (A)	ARCS LO (A)	ARCS HI (A)	SB218 SUB (B)	ARCS LO (B)	ARCS HI (B)
ARCS 3W SB218 HI	3-way stereo	47	SB218 SUB (A)	ARCS LO (A)	ARCS HI (A)	SB218 SUB (B)	ARCS LO (B)	ARCS HI (B)
ARCS 3W dVSUB LO	3-way stereo	48	dV-SUB SUB (A)	ARCS LO (A)	ARCS HI (A)	dV-SUB SUB (B)	ARCS LO (B)	ARCS HI (B)
ARCS 3W dVSUB HI	3-way stereo	49	dV-SUB SUB (A)	ARCS LO (A)	ARCS HI (A)	dV-SUB SUB (B)	ARCS LO (B)	ARCS HI (B)

Table 9: XTA DP226 Presets

1.11 CO24 CONTROL OUTPUT PANEL

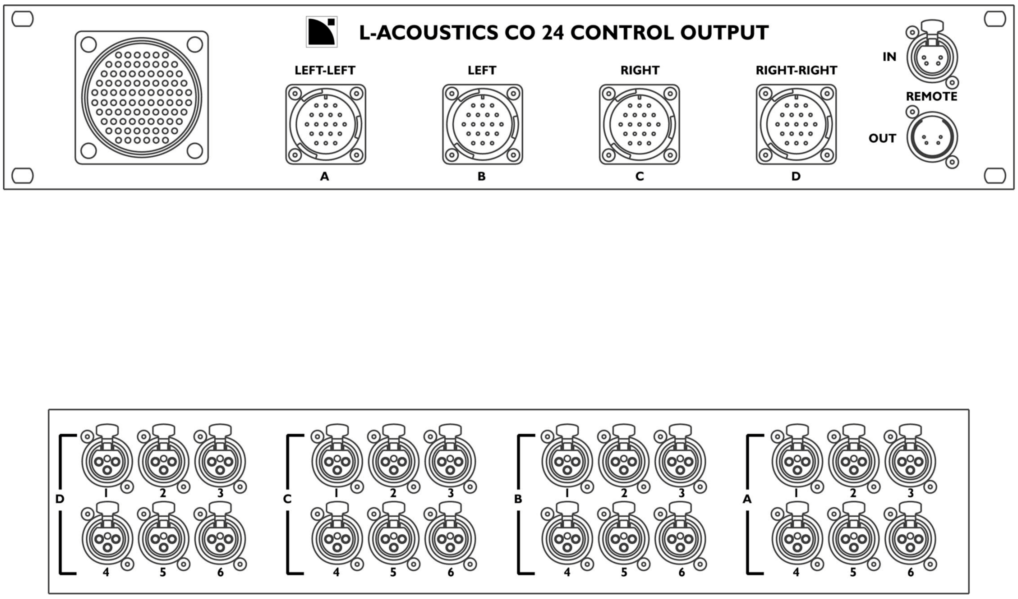


Figure 12: V-DOSC CO24 Control Output Panel

Digital signal processor outputs are assigned to MULTI return lines via the CONTROL OUTPUT panel. Internally, digital processor XLR outputs are patched to the 24x female XLR patch bay on the internal side of the CONTROL OUTPUT panel. All MULTI lines are paralleled with the Left-Left, Left, Right, and Right-Right CA-COM connectors. These individual CA-COM connectors can be used in situations where CONTROL RACKS are located onstage (eliminating the need for a MULTI DISTRO panel) or when it is desirable to run separate drive snakes to remotely located AMP RACKS. For example, in some cases, amplifier racks may be located at delay towers behind the FOH location and separate snake runs required or for smaller club/theatre shows, two Cross Link (DOM30) cables can be run for Left and Right instead of the MULTI. In addition, the availability of individual CA-COM connectors allows a LINK BREAKOUT cable to be connected to these outputs for testing purposes.

For amplifier remote control/monitoring, 4 pin XLR inputs and outputs are assigned directly to the appropriate MULTI lines.

This control panel configuration allows maximum flexibility while providing a scaleable architecture that can be used for small, medium and large systems. We will discuss the largest system application in detail since small and medium systems will adhere to the same MULTI line assignment standards and are considered as subsets of the large scale setup.

A large scale V-DOSC system typically consists of: Left-Left (L-L), Left (L), Right (R) and Right-Right (R-R) V-DOSC arrays. Each of the four arrays can have associated 2-way dV-DOSC downfill enclosures and SB218 subwoofers. Therefore, each L-L, L, R and R-R array requires 6 drive channels: 3 for V-DOSC, 2 for dV-DOSC and 1 for subs. Since there are 4 arrays, this requires 24 drive channels total. The 84 pin MASS W6 connector accomodates these 24 drive channels (72 lines) leaving 14 lines available for amplifier remote control.

It is important to have discrete drive for all four arrays for several reasons: (a) discrete drive allows for the relative time alignment of all 4 arrays, i.e., typically the L array will act as a time reference for the L-L array while the R array acts as a time reference for the R-R; (b) different sized arrays will require different band attenuation and equalization, i.e., typically the L-L and R-R arrays used for offstage coverage are smaller in terms of the number of elements; (c) discrete drive for all four arrays allows for the creation of stereo over larger audience areas, i.e., using the console's matrix outputs the stereo left signal can be applied to the L and R-R arrays while stereo right can be sent to the R and L-L arrays.

1.12 MD24 MULTI DISTRO PANEL

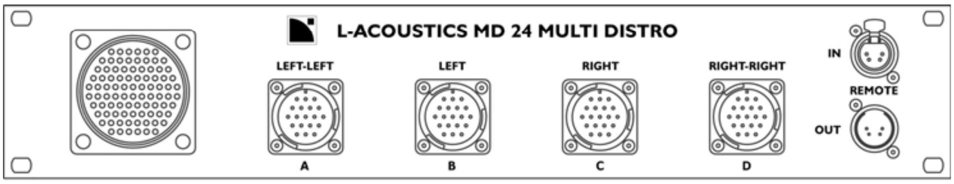


Figure 13: V-DOSC MD24 MULTI DISTRO Panel

As seen in the system block diagram of Figure 4, a MULTI DISTRO panel is required onstage for distribution of MULTI return snake lines from the FOH. A single MULTI DISTRO panel is required – typically, the MULTI DISTRO panel can be packaged separately and located either stage left or stage right depending on physical constraints regarding snake runs (alternatively, this panel can be mounted in the AMP RACK that is first in line for patching purposes).

An AMP LINK cable is run from the MULTI DISTRO panel to the appropriate CA-COM connector of the first AMP RACK, e.g., B lines for house left if the AMP RACK is located stage right. AMP LINK cables are then used to connect all subsequent stage right amplifiers so that all receive B lines (including subwoofer amp racks which are configured using the COMB connector as described in Section 1.6). A CROSS LINK cable is then used to distribute C lines for house right from the MULTI DISTRO panel cross stage to the stage left amplifiers. These racks are connected in the same way using AMP LINK cables. Separating left and right signal distribution lines is an effective way to avoid potential ground loop problems. Similar connections are performed for the A and D lines to accommodate Left-Left and Right-Right arrays, as necessary.

2. V-DOSC ARRAY SPECIFICATIONS

2.1 ISOCONTOUR IN THE HORIZONTAL PLANE

a) Horizontal Coverage Angle of a V-DOSC Array

According to AES recommendations, horizontal coverage angles are specified over an angular window with no more than 6 dB deviation. For the case of V-DOSC, the -6 dB points are at +/- 45° off axis and the horizontal coverage pattern is strictly symmetrical with respect to the 0° axis - a direct consequence of coplanar symmetry. Horizontal coverage of a V-DOSC array is independent of both the number of arrayed elements and the vertical configuration of the array. Horizontal coverage for the entire array remains equal to the horizontal coverage angle of a single V-DOSC element, i.e., 90° from 630 to 12.5kHz.

To summarize, a V-DOSC array has a constant horizontal coverage angle of 90° in the horizontal plane from 630 to 12.5k Hz with -6 dB points at +/- 45° off-axis.

b) Effective Coverage in the Horizontal Plane

In practice, strict adherence to polar specifications does not reflect the effective coverage of a sound system when it comes to the real world. Although a V-DOSC array is in fact radiating 6 dB less at 45° off-axis, this is generally not acceptable for most sound engineers (and audiences). A SPL window of
3 dB is more acceptable for defining the coverage of a system with constant distance and for a V-DOSC array of arbitrary height, the –3 dB coverage window is 70° from 630 to 12.5 kHz.

For sound design purposes, we will use a concept that takes into account the relative distance from the array, at different angles, having the same SPL. These isobaric (constant SPL) curves, or isocontours, are obtained by re-formatting polar curves on a linear scale. The horizontal projection of the isocontour can then be used directly to predict the effective coverage of a V-DOSC array in the horizontal plane. By overlaying the isocontour on a plan view model of the venue, the sound designer can adjust the aiming axis or panning of each array to get the best coverage results for a given audience layout.

The horizontal isocontour for V-DOSC is averaged from 630 Hz to 12.5 kHz since the horizontal coverage of the array is stable and remains constant over this frequency range. This also gives good consistency over what we call the clarity range since it is this bandwidth that is largely responsible for the perceived intelligibility. For lower frequencies, the isocontour is not preserved and becomes more omnidirectional as the horizontal coverage angle increases at lower frequencies.

For simulation purposes, L-ACOUSTICS provides horizontal isocontour data in the H-isocontour sheet in ARRAY 2000. For further details on how to use this data in sound design please see Section 2.3.

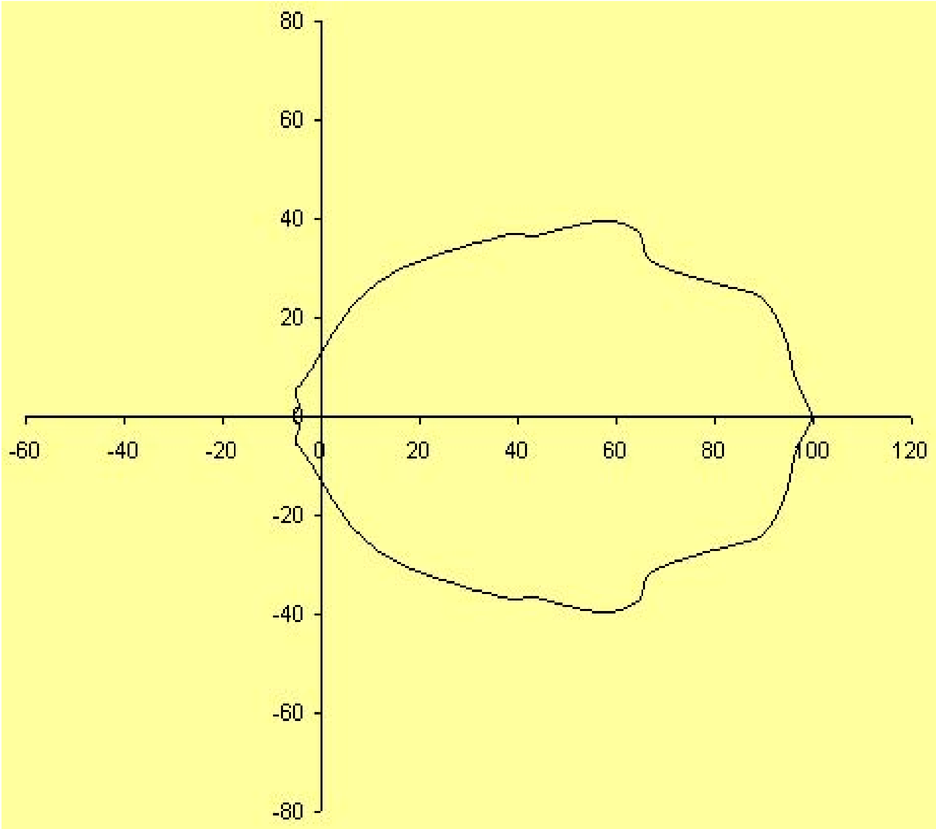


Figure 14: Horizontal V-DOSC isocontour averaged from 630 Hz - 16 kHz

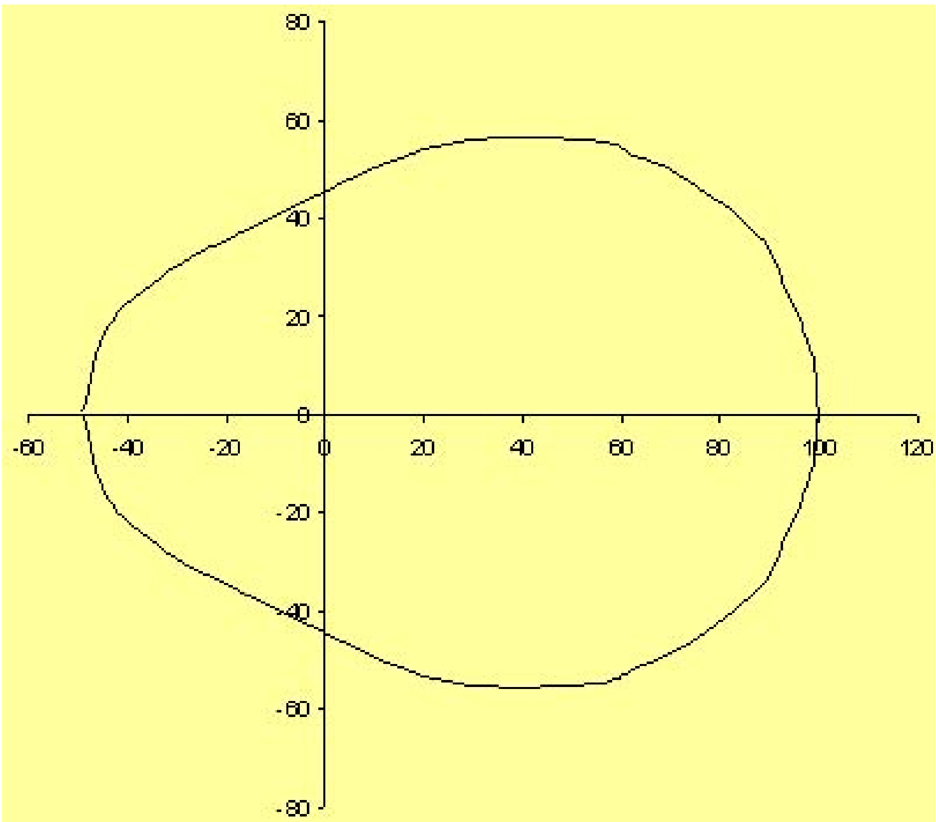


Figure 15: Horizontal V-DOSC isocontour averaged from 32 Hz - 630 Hz

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2.2 WAVEFRONT SCULPTURE IN THE VERTICAL PLANE

a) Flat V-DOSC Array

Flying or stacking V-DOSC elements with no angular spacing between enclosures produces a flat array. In this case, the whole array behaves acoustically like a vertically-oriented, flat, continuous, isophasic ribbon and radiates a CYLINDRICAL WAVEFIELD. The cylindrical wave expands in the horizontal dimension only and is defined by the section of a vertical cylinder over a predictable distance. The height of this section matches the height of the array (try to visualize a 90° cheese wedge). The overall vertical coverage angle of the array is defined by the top wall of the top enclosure of the array and the bottom wall of the bottom enclosure.

According to the Fresnel description of wavefields, a cylindrical wavefield expands from a source over a certain distance then becomes a "classical" spherical wavefield. Detailed analysis shows that a flat
V-DOSC array radiates a spherical wavefront at the lowest frequencies and a cylindrical wavefront at higher frequencies at any location within its coverage window. The boundary between the cylindrical wavefield and the spherical wavefield is both frequency and height dependent (see Appendices 5 and 6 for full theoretical details).

In spherical mode, the wavefront expands in two dimensions, thus producing a SPL attenuation of 6 dB with doubling of distance. In cylindrical mode, the wavefront expands linearly with distance, thus producing only 3 dB of attenuation when doubling the distance.

The net result is that at large distances, the tonal balance is progressively tilted by a HF enhancement since the V-DOSC system is, in essence, more efficient at projecting HF energy than LF. This is an important benefit of the V-DOSC system. With distance, this tilt in tonal balance is offset by air absorption at large distances in open air situations and by both building material absorption and air absorption indoors, resulting in spectrally balanced sound over the largest area possible.

Since the flat array configuration maximizes energy and intelligibility with distance, it should mainly be used for long throw applications or in very reverberant rooms. It is also common to use a flat array section at the top of a variable curved array for maximum throw in arena and stadium installations. In some cases, the upper elements of flown V-DOSC arrays are ratchet strapped together in order to provide such a long throw (flat) section.

b) Curved VDOSC Array

A curved V-DOSC array (stacked or flown) is obtained by using ANGLE straps to provide the desired angle between each element and inserting SPACER blocks between adjacent elements to maintain the desired angle.

If the angle between two adjacent V-DOSC elements is smaller than 5°, WST criteria are satisfied and the array behaves like a continuous, curved radiating ribbon. If the angle between elements exceeds 5°, WST criteria are no longer valid over the full audio frequency range. Practically, a larger angle produces neither desirable nor predictable results - elements radiate individually and the benefits of collective coupling are lost. This is why ANGLE straps are available only up to 5°.

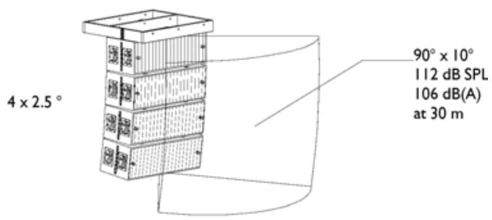
There are two types of curved V-DOSC array: constant curvature and variable curvature. For the first case, the angle between all adjacent elements is constant while for the second case, it varies within the defined range of 0° to 5°.

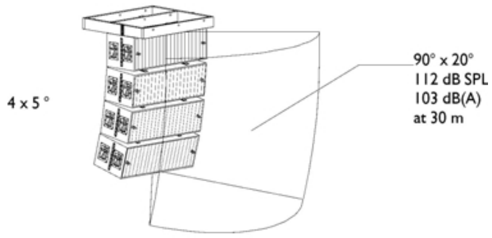
c) Constant Curvature V-DOSC Array

For a constant curvature array, the vertical coverage angle is nominally N x A° where N is the number of elements in the array and A° is the constant angle between each adjacent element. For example, a curved array of 8 V-DOSC elements can provide a maximum vertical coverage of 8 x 5° = 40° while still satisfying WST criteria.

The constant curvature array is the simplest type of curved V-DOSC array. This configuration should only be used for smaller sized arrays or when the geometry of the audience is unknown. Since an array of constant curvature radiates the same amount of energy in all directions over the nominal vertical coverage range (N x A°), this type of array is of practical use only when the entire audience is sitting at the same distance from the array.

However, in most venues, a V-DOSC array will have to cover an audience sitting at varying distances from the array. A constant curvature array would produce excessive SPLs in the first rows compared to the remote audience, even when the vertical coverage angle is correct. Therefore, a constant angular spacing between elements is generally not useful for most applications. If this configuration is used, the gain of the amplifiers powering the high frequency section of the lower V-DOSC elements should be progressively reduced. However, such attenuation results in a global loss of energy.





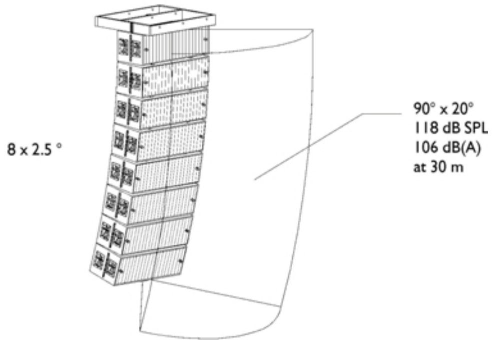


Figure 16: Constant Curvature Array Examples.

Figure 16 shows the influence of array curvature on the SPL within the defined vertical coverage sector and how this varies relative to the frequency range. Assume that the array consists of 4 V-DOSC elements and covers a vertical angular sector of S°. If the angular spacing A is divided by 2, the value of S is also divided by 2 in the clarity domain but remains unchanged at low frequencies. By comparison, considering an 8 element V-DOSC array covering the same sector S°, the SPL increases by 3 dB in the clarity domain (A-weighted) and by 6 dB at lower frequencies (unweighted).

d) Variable Curvature V-DOSC Array

The ability of V-DOSC to perform Wavefront Sculpture allows the designer to adapt the wavefront to suit specific audience requirements through the use of variable curvature arrays.

Since each V-DOSC element produces a flat isophasic wavefront, it is possible to couple as many elements as is needed in one vertical sector in order to focus energy in this direction. This is accomplished by reducing the angular spacing (A) between elements within this sector, or conversely by increasing A (up to a maximum of 5°) in order to lower the SPL in another direction. This is the basic principle that allows energy to be more uniform throughout the audience.

Shaping the vertical isocontour is the key to Wavefront Sculpture Technology.

The ARRAY 2000 spreadsheet allows the designer to shape the vertical isocontour of a V-DOSC array by displaying the results of various angular spacing selections and the following section gives complete details on variable curvature array design.

2.3 COVERAGE PREDICTIONS USING ARRAY 2000

L-ACOUSTICS has developed a fast, easy-to-use prediction spreadsheet named ARRAY 2000. ARRAY 2000 operates under EXCEL (version 97) and is available for both Windows and MacIntosh. The spreadsheet can predict coverage for flat, constant curvature and variable curvature arrays.

The first four worksheets represent vertical cut views (section elevations) of the audience in the xz plane and show the intersection of the vertical aiming direction of each element with the audience (impact zones). The direction of each element is calculated automatically according to the user-input angles A°. All angles are referenced with respect to the site angle of the top element which should be aimed at the rearmost part of the audience. These cutview sheets are used to shape the vertical isocontour of either V-DOSC or dV-DOSC arrays to match the audience area.

Note: Cutview sheets ARRAY1 and ARRAY2 are used to simulate V-DOSC arrays while Cutview sheets dVARRAY1 and dVARRAY2 are used for dV-DOSC. In addition, dVARRAY1 can be used to simulate dV-DOSC used as downfill (under V-DOSC) while dVARRAY2 can be used to simulate dV-DOSC used as upfill/longthrow (on top of V-DOSC).

The H-ISOCONTOUR sheet displays the horizontal isocontour (see Section 2.1) of all defined arrays projected onto a plan view of the audience area in the xy plane.

The SUB ARC sheet is used to calculate delay taps based on the physical configuration of a given subwoofer array for electronic arc processing (see Section 3.4 g)

The ROOM DIM sheet can be used to help calculate xz cutview parameters based on room measurements.

The DATAcutview and DATAiso sheets are used for calculation purposes and should not be altered.

In general, all input data should be entered into the cells in black. Results are displayed in red.

CUTVIEW SHEETS (ARRAY1, ARRAY2, dV-ARRAY1, dV-ARRAY2)

a) Input Data

In AUDIENCE GEOMETRY cells, the designer enters the distances and elevations that define the audience area according to a section view along the main zero degree axis of the system. The origin of the x-axis is referenced to the top rear corner of the top element while the origin of the z-axis is at floor level, i.e., the x-axis is distance or range along the desired array axis and the z-axis is height above floor level. A second cut-view can also be specified at an off-axis angle within the coverage pattern of the array. Typically the second cut-view is taken at 45° offstage in order to confirm coverage throughout all portions of the audience. The "listening level" cell is the effective hearing level or ear height relative to floor level (1.2 metres for a seated audience, 2 metres for standing).

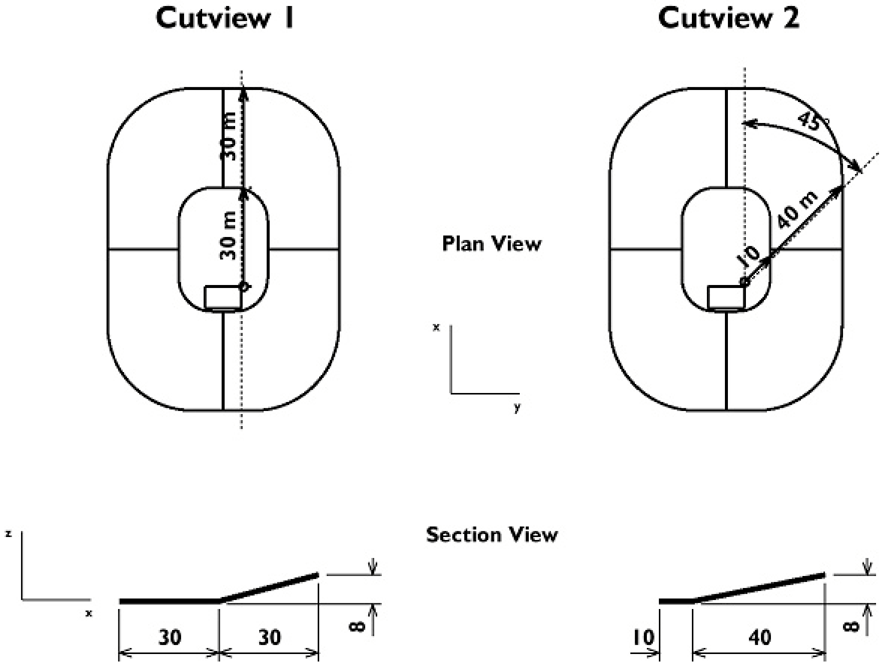


Figure 17: Defining Cutview Dimensions

Although detailed blueprints are not necessarily required, the more information that can be obtained on a venue for defining the audience geometry the better. Typically, plan and section views are available for most venues upon request. In situations where such documentation does not exist, there are a number of options: use a tape measure or laser range-finder on site to perform dimensional measurements. Alternatively, L-ACOUSTICS has had good results with the Bushnell Yardage Pro 600 for field measurements. Apart from being useful for defining room geometry, this tool can also be used for determining delay time settings during system tuning, for locating laser beams during array trim and angle adjustment (and even on the golf course on days off!).

The ROOM DIM sheet is provided in ARRAY 2000 to assist in calculating cutview data from room measurements (see Figure 18 for details).

Note: the calculation of elevation Z2 is susceptible to small errors in distance measurements and should always be verified with a tape measure whenever possible. Combined distance/angle measurements are typically more accurate than distance only measurements when calculating Z2.

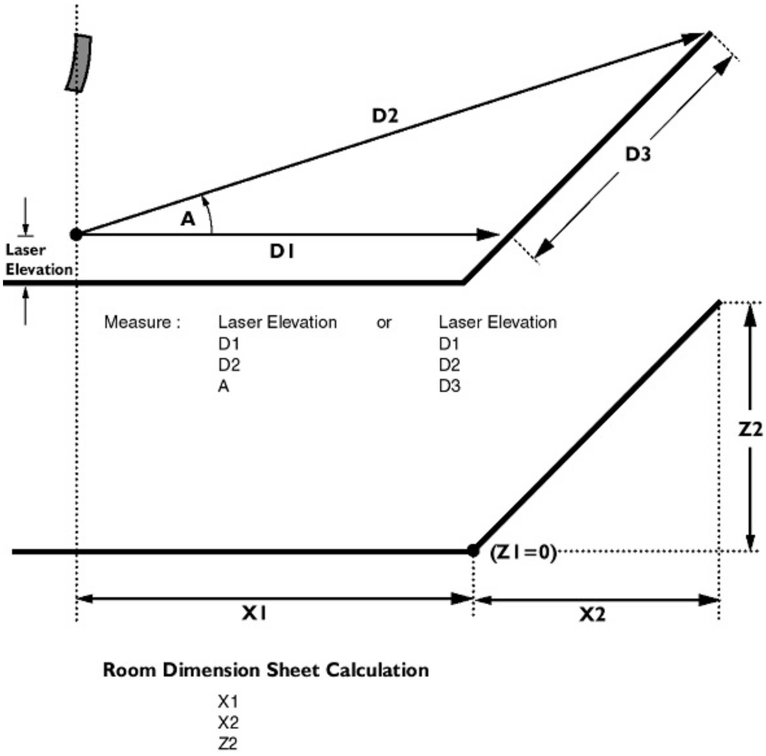


Figure 18: Parameters for the ROOM DIM Utility Sheet in ARRAY

In V-DOSC ARRAY#1 cells, the designer enters the number of V-DOSC elements (16 maximum), the elevation of the bumper and the autofocus adjust angle. Normally, ARRAY 2000 automatically focusses the top element to the rear of the audience geometry that is defined in Cutview 1. Autofocus adjust can be used to adjust the overall focus of the array and DOES NOT CORRESPOND TO THE OFFSET ANGLE OF THE BUMPER.

For safety reasons, the maximum upward tilt angle for the array (given by Site #1 to next) is approximately 5 degrees. The results of detailed mechanical load calculations are displayed in the MECHANICAL DATA cells in ARRAY 2000 software to determine exact array tilt angle limits.

NOTE: Always refer to the MECHANICAL DATA cells in ARRAY 2000 to verify that safe rigging conditions apply with respect to load distribution (see below for further details).

The designer then chooses the angular spacing between elements from the available values (0.75°, 1.3°, 2°, 3°, 4°, 5.5°). The red lines show the aiming directions of all elements, where each line is aligned with the bottom of its respective enclosure. Note that the displayed top element corresponds to the BUMPER, not the first element of the V-DOSC array. XZ cells can be used to enter additional room features such as balcony profiles, stage/proscenium details, FOH mix position, etc.

b) Optimization Procedure

The calculated beam display indicates the effective vertical coverage of the array above F_1, where F_1 is defined as the low frequency limit of the clarity domain, i.e., above F_1 WST criteria are fully satisfied and cylindrical wave propagation applies (see Appendix 6 for further details). Intersection of beams with the audience (square blocks = impact zones) represents the dispersion of sound pressure level over the audience. The best results are achieved when the audience intersection points have equal spacing between them. In this case, the SPL decreases by 3 dB when doubling the distance (see Figure 19 for details).

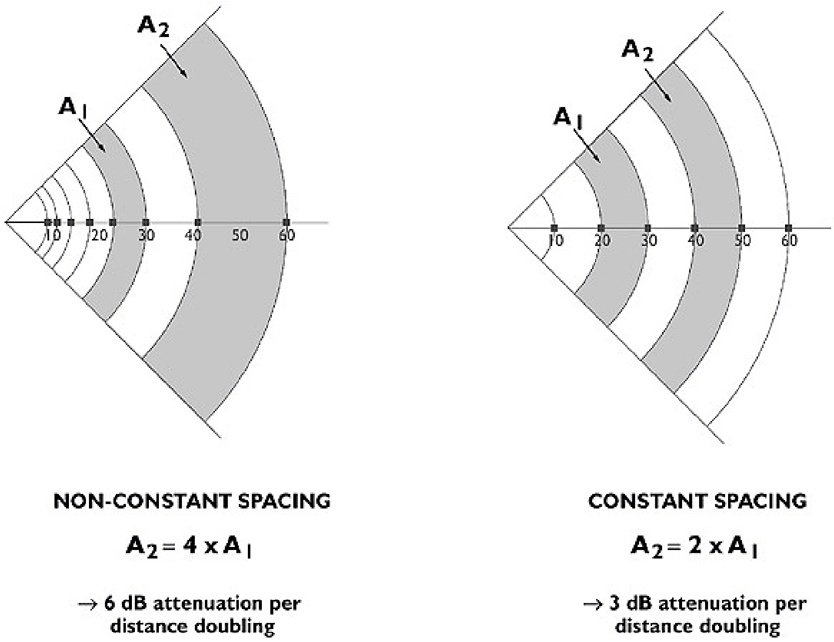


Figure 19: Optimizing Array Element Focus By Adjusting For Equal Spacing

Typically, optimum coverage is obtained iteratively by varying the height of the array and the element angles (#1 to next, #2 to next, etc). The designer manually performs the optimization by visually referring to the spacing between audience intersection points after making changes to the array. Once equal spacing has been achieved, the designer has successfully optimized the performance of the system by shaping the array's vertical isocontour to match the geometry of the audience. Angle strap values, bottom element elevation, site angles for top and bottom elements and trim height parameters are then recorded and used for actual installation of the system (see Output Data).

Note: There is a difference between NOMINAL ANGLES for FLOWN versus STACKED arrays. When V-DOSC enclosures are stacked, the rear corners of cabinets are touching (due to gravity) and when flown there is a small gap.This difference (approx 1 cm over the depth of the cabinet) corresponds to an additional 1 degree for stacked versus flown systems. Therefore, to model stacked system coverage users should enter: 1.75, 2.3, 3.0, 4.0, 5.0, (do not use) instead of 0.75, 1.3, 2.0, 3.0, 4.0, 5.5.

c) Output Data

In the columns adjacent to where angle strap values are entered, the site angles (i.e., what you would measure if you put a digital inclinometer on #1, #2, etc elements) and the wavepath (throw distance) for each element are tabulated.

Note: the site angle for element #1 is essentially equal to the BUMPER site angle since the first element is attached to the BUMPER with minimum separation (within physical tolerance limits) using the BUMP ANGLE strap. When the system is pointing down (negative site angle for #1) the top element will tend to close against the bumper - normally this is indicated by a negative 2-Angle Stress value in MECHANICAL DATA cells. When pointing upwards, there will be a small gap between the first element and the BUMPER and therefore a difference between site angle #1 and the BUMPER site angle. Therefore, you should always attach a laser and/or remote digital inclinometer to the top of element #1, not the BUMPER itself, in order to accurately measure the true focus of the top element.

Also tabulated are continuous A-weighted SPL estimates throughout the vertical coverage pattern of the array on an element-by-element basis. These dBA estimates are derived using a Fresnel-type calculation (see Appendix 2) using a 2 kHz reference frequency for a +4 dBu nominal input signal level (17 dB of headroom remains). Since the dBA calculation considers discrete V-DOSC elements (not sections of the continuous radiating line source array) the resolution of this calculation is not

sufficient for the user to design for constant dBA throughout the audience area. Users are advised to refer to the visual spacing between element focus and use the dBA estimates as a guideline only.

In ARRAY GEOMETRICAL DATA cells, the physical dimensions of the array are displayed including: the Overall Depth of the Array (in the x dimension referenced to the downstage rigging point), the Overall Height of the Array (in the z dimension), and the Bottom Element Elevation (referenced to floor level). The bottom element elevation is used for flying the system and the Depth/Height information is useful to determine if the array will physically fit in a given space (scaffold bay, clearance to proscenium wall etc). Please see Figure 20 for further details.

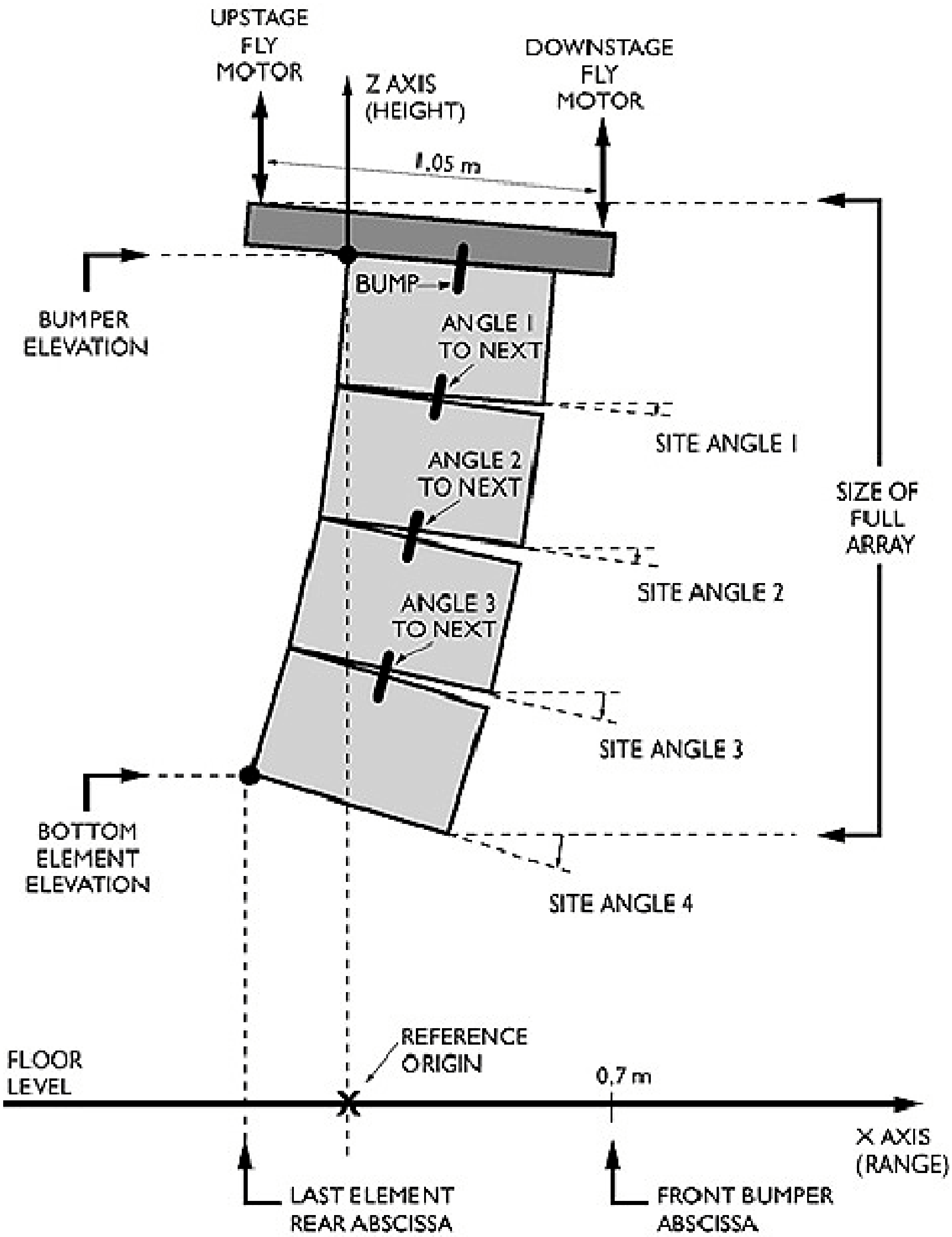


Figure 20: Physical Rigging Parameters for ARRAY

ACOUSTICAL PREDICTION data gives the continuous unweighted SPL of the array referenced to 1 m and the unweighted SPL of the array at a selected distance (enter the distance in the black cell).

This calculation is based on a 200 Hz reference frequency and correlates well with the unweighted SPL (as opposed to the A-weighted element-by-element SPL estimate). The peak unweighted SPL for a single array as well as an estimate of the peak unweighted SPL for 2 arrays is also given. Note that these unweighted SPL estimates do not include additional contributions due to subwoofers.

Vertical coverage of the array is calculated as the addition of intercabinet angles. As discussed above, this coverage becomes effective at F_1, defined as the lowest frequency of the clarity domain. For all frequencies higher than F_1, the vertical coverage angle is controlled within the nominal vertical coverage angle. Above F_2, the vertical coverage angle perfectly matches the nominal value. Some beaming (vertical coverage narrowing) may occur at F_3, especially when the array is of constant curvature type. Further theoretical details related to the calculation of F_1, F_2 and F_3 are given in Appendix 6.

Finally, MECHANICAL DATA gives an estimate as to the rear versus front motor and balancier versus BUMP angle strap load distribution. These load distributions depend on the size and shape of the array as well as the array site angle (equal to Site #1) which in turn affect the location of the centre of gravity.

Important things to note:

1) ARRAY WEIGHT includes V-DOSC enclosures, the V-DOSC BUMPER and angle strap weights only. Loudspeaker cable weights, steels and motor weights are not included.

2) Calculation of the REAR LOAD is within 20% error. When the rear motor load goes to zero, Maximum Site Angle is displayed.

3) Calculation of the FRONT LOAD is within 20% error. When the front motor load goes to zero, Minimum Site Angle is displayed.

4) 2-LEG STRESS refers to the stress on the top enclosure's rotating legs (balanciers) and is accurate within 20% error. NOTE: the effect of rear ratchet strapping is not taken into account.

5) 2-ANGLE STRESS refers to the stress on the top enclosure BUMP angle straps and is accurate within 20% error. If the angle strap load rating is exceeded there is a WARNING indication. *Note: the effect of additional rear ratchet strapping is not taken into account.*

IF YOU ARE APPROACHING A WARNING INDICATION DO NOT OVERTIGHTEN RATCHET STRAPS UNDER ANY CIRCUMSTANCES. USE SPACER BLOCKS INSTEAD.

For more details on ratchet strap issues, please refer to Section 4.2.

H-ISOCONTOUR SHEET

The H-ISOCONTOUR sheet is used to check horizontal coverage by mapping a projection of the horizontal isocontour of the defined V-DOSC and dV-DOSC arrays onto the user-defined audience area. By matching horizontal coverage to the audience area, H-ISOCONTOUR can be used to check array placement and aiming as well as to determine whether offstage fill, front fill or center cluster arrays are required. Two audience areas can be defined and the coverage of up to four arrays displayed (2x V-DOSC, 2x dV-DOSC). Calculation assumptions include: 3 dB SPL reduction with doubling of distance (i.e., arrays have been designed for constant spacing using their respective Cutview sheets); doubling the number of cabinets adds 3 dB to the A-weighted SPL; anechoic or reflection-free conditions (direct sound only).

a) Input Data

Just as for the Cutview sheets, user input data cells are in black and results are displayed in red.

To define a plan view of the audience area, the user inputs x (range) and y (distance off-centre) coordinates in the Contour 1 and Contour 2 cells. As coordinates are entered, the display of the audience area is automatically updated and a mirror image drawing scheme is used so that only half the room needs to be defined. It is only necessary to define Contour 1, however, Contour 2 is useful to represent balconies, stage thrusts, proscenium opening, FOH location etc.

When V-DOSC and dV-DOSC arrays are defined (in ARRAY1,2 and dVARRAY1,2 Cutview sheets respectively), they are automatically displayed in the H-ISOCONTOUR sheet with the X Location of each array referenced to the defined Offset Distance taken from each arrays' respective Cutview sheet. The parameter "Isocontour at Distance (m)" refers to the throw distance for the top element of the respective array and is given relative to the defined Offset Distance.

The user then enters the "Console Output Signal (dBu)" for each array, i.e., output level of the mixing desk (typically 0 VU on the console meter = +4 dBu) and the Continuous A-weighted SPL is tabulated. This corresponds to the SPL that would be obtained along the isocontour of each array. The Console Output Signal can be increased to up to 17 dBu - at this point the amount of headroom available in the system goes to zero and the user has an indication as to the peak A-weighted SPL that will be available along the isocontour. Further increases in the Console Output Signal will produce a CLIP indication reflecting amplifier clip.

The user can also define the y coordinates for each array (distance off center line) and the azimuth angle in degrees (i.e., aiming or panning angle of the array). Note: to simulate a centre cluster, simply set "Y location" equal to zero.

b) Optimization Procedure

Typically, the optimization procedure begins by using the ARRAY1, ARRAY2, dV-ARRAY1 or dV-ARRAY2 Cutview sheets to determine the number of array elements for A1, A2, A3 and A4. H-ISOCONTOUR is then used for adjustment of array separation and panning angles in order to ensure adequate audience coverage at a desired A-weighted SPL and to match coverage to the audience area.

In some cases, when horizontal coverage is an important design issue, simulation can start with the H-ISOCONTOUR sheet first in order to predetermine the 0 and 45 degree axes prior to more detailed Cutview simulation.

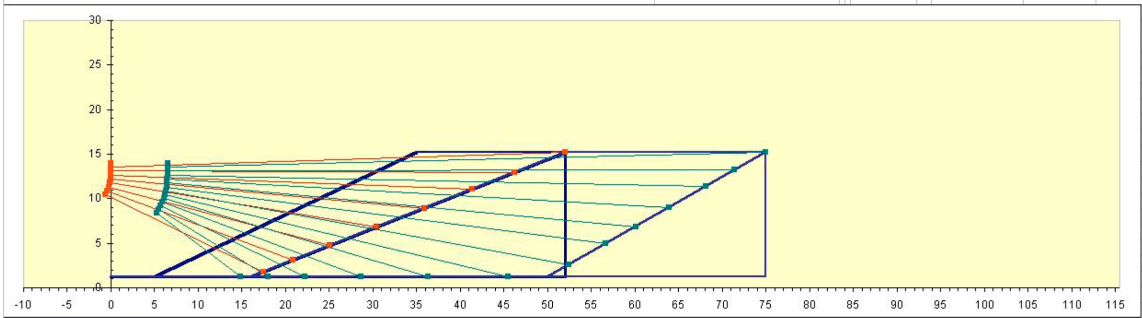
c) Output Data

Output data is directly displayed as the projection of the horizontal isocontour on the defined audience area. The A-weighted SPL and amount of headroom in the system are given for each array. Note that the displayed ISOCONTOUR for each array is terminated in a line that is referenced to where coverage starts for the bottom element. Therefore, H-ISOCONTOUR gives a direct indication as to the areas where coverage is lacking and offstage fill, center fill or delay clusters are required. The overlap between L, R arrays also gives an indication as to which portions of the audience will experience stereo imaging.

Note: At this time it is not possible to properly simulate the transition between the dV-DOSC to V-DOSC isocontours when dV-DOSC is used for downfill or upfill with V-DOSC.

ARRAY 2000 SPREADSHEET CALCULATION EXAMPLE

V-DOSC ARRAY CONFIGURATION - WAVEFRONT SCULPTURE PREDICTION



AUDIENCE GEOMETRY		X	Z
Cut-view 1			
Section X1	50.0m		
Elevation Z1	0.0m		
Section X2	25.0m		
Elevation Z2	14.0m		
Cut-view 2			
Section X1	16.0m		
Elevation Z1	0.0m		
Section X2	36.0m		
Elevation Z2	14.0m		
Listening level	1.2m		
V-DOSC ARRAY #2			
Offset Distance	6.5m		
# of Elements	13		
Bumper Elevation	14.0m		
Autofocus Adjust	0.0°		

Continuous A-Weighted SPL estimate for +4dBu input

	Angle	Site	Wavepath	SPL
#1 to next	1.30°	1.4°	68.5 m	93 dBA
#2 to next	1.30°	0.1°	64.9 m	97 dBA
#3 to next	2.00°	-1.2°	61.6 m	100 dBA
#4 to next	2.00°	-3.2°	57.5 m	98 dBA
#5 to next	2.00°	-5.2°	53.9 m	99 dBA
#6 to next	3.00°	-7.2°	50.7 m	96 dBA
#7 to next	3.00°	-10.2°	46.9 m	97 dBA
#8 to next	3.00°	-13.2°	40.3 m	98 dBA
#9 to next	4.00°	-16.2°	31.5 m	100 dBA
#10 to next	5.50°	-20.2°	24.2 m	102 dBA
#11 to next	5.50°	-25.7°	18.4 m	105 dBA
#12 to next	5.50°	-31.2°	14.6 m	107 dBA
#13 to next		-36.7°	12.1 m	108 dBA
#14 to next		0.0°	0.0 m	#DIV/0!
#15 to next		0.0°	0.0 m	#DIV/0!
#16 to next		0.0°	0.0 m	#DIV/0!

ARRAY GEOMETRICAL DATA	
Overall Depth of Array (x dim)	1.98 m
Overall Height of Array (z dim)	6.07 m
Bottom Element Elevation	8.42 m

ACOUSTICAL PREDICTION	
DISTANCE from array	60 m
Reference Frequency	200 Hz
Continuous SPL (1 element, 1m)	130 dB
Continuous SPL per ARRAY	115 dB
Peak SPL per ARRAY	121 dB
Estimated Peak SPL for 2 arrays	125 dB

VERTICAL COVERAGE	38.1°
Directivity Control from F1	105 Hz
Constant Directivity above F2	359 Hz
Possible Beaming at F3	194 Hz

COMMENTS

ANGLEs available:
0.75, 1.3, 2.0, 3.0, 4.0, 5.5

MECHANICAL DATA		
Gravity abcissa	-0.1 m	
Gravity elevn	11.0 m	
Array Weight	1477 kg	3256 lbs
Rear load	981 kg	2164 lbs
Front load	495 kg	1092 lbs
2-Leg stress	1861 kg	4102 lbs
2-Angle stress	-384 kg	-846 lbs

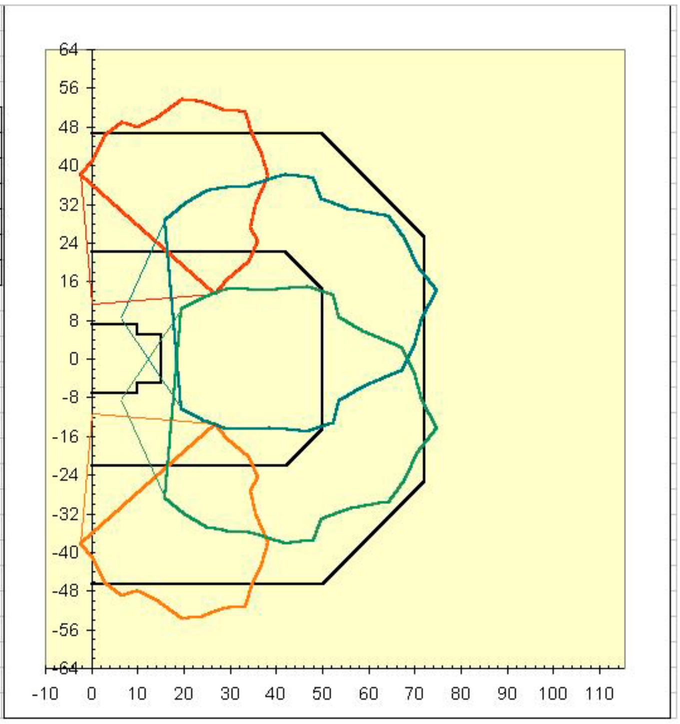
CUTVIEW SHEET

HORIZONTAL ISOCONTOUR

ARRAYS	A1	A2	A3	A4
Isocontour at distance (m)	52	69	0	0
Console output signal (dBu)	4	4	4	4
X location (m)	0	6.5	0	0
Y location (m)	11.2	8.3	0	0
Azimuth angle (deg)	50	5	0	0
Headroom (dB)	13	13	7	7
Cont A-weighted SPL (dBA)	92	93	######	######

AUDIENCE CONTOUR (meters)

CONTOUR 1		CONTOUR 2	
X	Y	X	Y
0.0	22.1	0.0	46.5
42.0	22.1	50.0	46.5
50.0	14.5	72.0	25.2
50.0	0.0	72.0	0.0
0.0	7.0		
10.0	7.0		
10.0	5.0		
15.0	5.0		
15.0	0.0		



HORIZONTAL ISOCONTOUR SHEET

Figure 21: ARRAY spreadsheet calculation example

3. ELEMENTS OF SOUND DESIGN

3.1 MULTIPLE ARRAY CONCEPTS

a) Reducing Array Interaction

It is well known that the collective radiation of sound by a number of loudspeakers located close to each other results in interference that creates frequency- and position-dependent interference lobes. The only coherent way to couple loudspeakers is to meet Wavefront Sculpture Technology criteria, which, for the case of V-DOSC is met in the vertical domain.

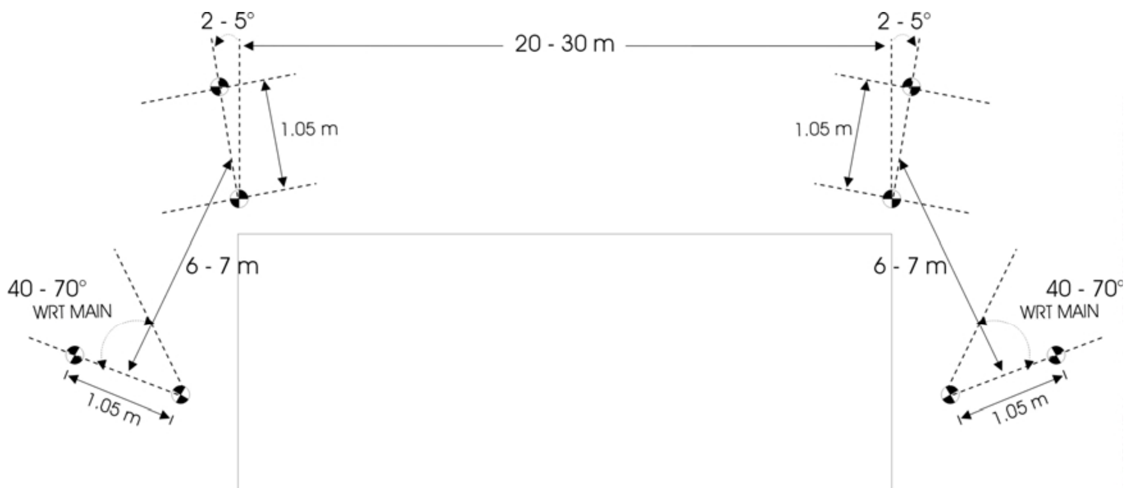
When the horizontal coverage of a V-DOSC array (90° nominal, 70° effective) is not sufficient, the solution is definitely not to place a second array directly beside the first one (see Appendix 1 for further elaboration). The correct approach is to utilize a second array which is focused on another portion of the audience (typically at 45° - 70° relative to the first array) and spaced at least 6-7 meters (approximately 20 ft) away from the first array.

Given this separation, interference only occurs in the low frequency range and there are no audible intelligibility losses for two reasons: 1) the first main cancellation is shifted lower in frequency (example, 24 Hz for 2 arrays of the same size, spaced 7 metres) and tends to be masked or filled in by room reverberation; 2) by focussing the arrays at different panning angles, comb filtering interaction is lessened since their overlap region is reduced. In addition, the ear cannot resolve tightly spaced comb filtering notches at higher frequencies throughout the overlap region.

The array closest to the stage is usually the larger of the two arrays. This array is considered as the time reference and any other array is delayed with respect to it. This is valid for arrays fed with the same signal (in a stereo configuration, it is obvious that the left array is not delayed with respect to the right one or vice-versa).

Experience has shown that this is a very flexible approach that can cover any type of audience. An additional advantage of multiple arrays is improved resistance to wind effects in open-air situations. Another benefit is improved perception of stereo effects throughout the audience area – something which should not be limited to just the mix position (i.e., arrays can be run in cross-panned stereo with L-L (right), L (left), R (right) and R-R (left)).

Beyond the basic solution of coverage problems, multiple source arrays open up many possibilities for creating a spatial soundscape, thus providing a powerful tool for sound design and creativity. A number of suggested configurations suitable for use in a wide variety of situations are given below in Section 3.6. These suggested configurations should serve as a useful starting point for detailed sound design using ARRAY 2000.



Typical Rigging Plot for a LL, L, R, RR System

b) Achieving Optimum Coverage

Using the isocontour drawn on a blueprint or the data provided in ARRAY 2000 (H-ISOCONTOUR), it is easy to achieve correct horizontal coverage for a complete system consisting of several V-DOSC arrays. Parameters for each array such as spatial coordinates, axial direction are chosen by the sound designer and entered in ARRAY 2000 with respect to the basic geometry of the audience.

The displayed horizontal isocontours should overlap to a certain extent and cover the majority of the audience (for the amount of overlap see Section 3.3 b for a discussion of the tradeoffs between stereo perception and intelligibility). The remaining uncovered areas should be covered with smaller 2-way fill speakers such as ARCS or dV-DOSC. Alternatively, in some cases, a distributed front fill system using MTD115a, MTD112, MTD108a or EX112 loudspeakers can be highly effective in complementing V-DOSC system coverage.

3.2 STACKED OR FLOWN?

Although flown systems are generally preferred by most sound engineers, there are good arguments to support both solutions. In many cases the answer is dictated by logistics that are venue-specific, i.e., sometimes it simply isn't possible to fly PA.

"Stacking" onstage lowers the perceived sound image to stage level which is beneficial in small venues. Stacking also offers more low frequency SPL due to enhanced floor coupling and since V-DOSC has less SPL attenuation from the front to the back of the audience than traditional systems, this allows a stacked system to project further. In addition, for geometric reasons a stacked array can provide more extended vertical coverage than a flown one - this can be seen using the ARRAY 2000 spreadsheet and is simply related to the geometry of the audience to be covered.

For these reasons, stacking makes sense in small configurations where only a few elements can optimize both audience coverage and low frequency response.

"Flying" is the best solution to achieve uniform sound pressure level and even tonal balance over the entire audience provided that the number of elements arrayed is sufficient to provide the necessary front to rear coverage. Flying is also an excellent solution for sightline problems that commonly occur. Another practical consideration is that if more than 6 elements are to be arrayed, it is necessary to fly them for stability reasons.

In flown configurations, additional speakers are typically added to the array to cover center- or front-fill requirements. Good candidates for this application include ARCS or dV-DOSC. As an alternative to flown fill, ARCS speakers can be stacked on stage (preferably close to the subwoofers). Other possible front fill enclosures include: MTD115a, MTD112, MTD108a or EX112 loudspeakers

a) Stacking Guidelines

The stacking system is rated for a maximum of 6 V-DOSC elements.

For this type of installation, the precise nature of V-DOSCs' vertical coverage allows little margin for error. The designer must know if the audience is standing or seated - the bottom of the array should be higher than the ears of the first rows of the audience and the lowest element tilted downwards by adjusting the BUMPER screwjacks. It is also important to keep in mind the one degree difference in angle straps for stacked versus flown systems (see Section 2).

If the bottom of the array is too low, the first rows receive too much SPL and audience members directly in front of the system behave as an acoustic screen for the following rows. Ideally, the bottom of the array should be slightly above the audience (not lower than 2 m or 6.5 ft above floor level), with the lowest element tilted downwards as necessary. For complete details on stacking procedures, please refer to Section 4.1.

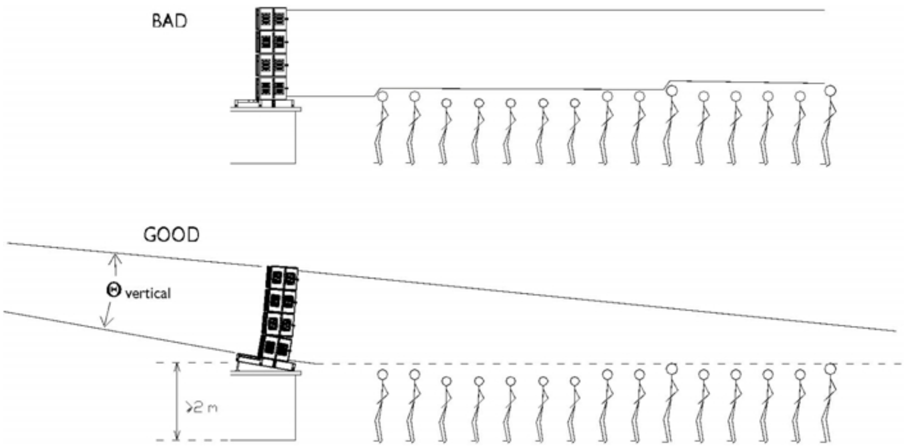


Figure 22: Illustration of Stacking Guidelines

b) Flying Guidelines

The flying system is rated for a maximum of 16 V-DOSC elements.

Particular attention must be paid to the height at which the array is flown when predicting the vertical coverage in ARRAY 2000 Cutview sheets. One will discover that in many cases it is easier to optimize coverage at a certain height versus any other height. As a rough guideline, the elevation of a 12 element arena system is typically between 11-15 m (36-50 ft), depending on the geometry of the audience.

Note that the angular configuration of the array should not be adjusted by considering the on-axis cutview alone – always consider the audience geometry off the main axis, especially from 35° to 45° off-axis on the offstage side. It is important to be sure to check that you are not lacking in offstage coverage and require additional fill systems.

It is quite common to have venues where there are two sections of the audience area that have two different slopes. In this case, coverage of the areas which are close to the borderline must be determined carefully and V-DOSC arrays should be focused differently on the two sections.

Finally, to effectively complete any V-DOSC installation, either stacked or flown, the operator has to carefully verify by actual measurement that the parameters in ARRAY 2000 Cutview sheets have been implemented correctly. Tools that are useful for this purpose are described in Chapter 6. Detailed flying and verification procedures are described in Section 4.2.

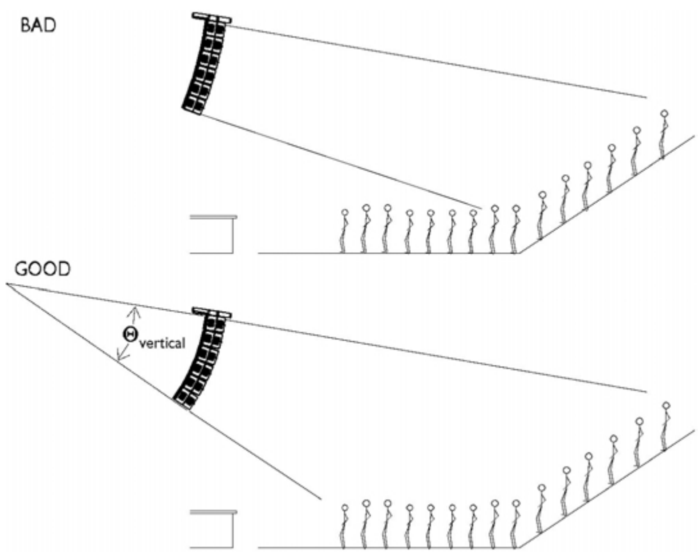


Figure 23: Illustration of Flying Guidelines

3.3 THE LEFT/RIGHT CONFIGURATION

a) The Standard Configuration

Although not the best technical solution, the left/right configuration meets both visual and practical criteria and is most commonly used. V-DOSC is a dramatic improvement over conventional systems but, by nature, the stereo imaging of a standard left/right system is questionable for most of the audience and some compromise with respect to overall tonal balance has to be accepted.

The biggest problem for any left/right system is non-uniformity of tonal balance over the audience. Typically, an excess of low frequency energy builds up in the middle along a narrow path from the stage to the back of the venue. This is often accompanied by a reduction of intelligibility over the same area. The net result is a “thick” sound response in the middle, “aggressive” when directly on-axis with one side of the system, and “thin” offstage. These effects are due to the path length difference interference effects inherent in any left/right system which, in turn, produce frequency- and position-dependent peaks and dips.

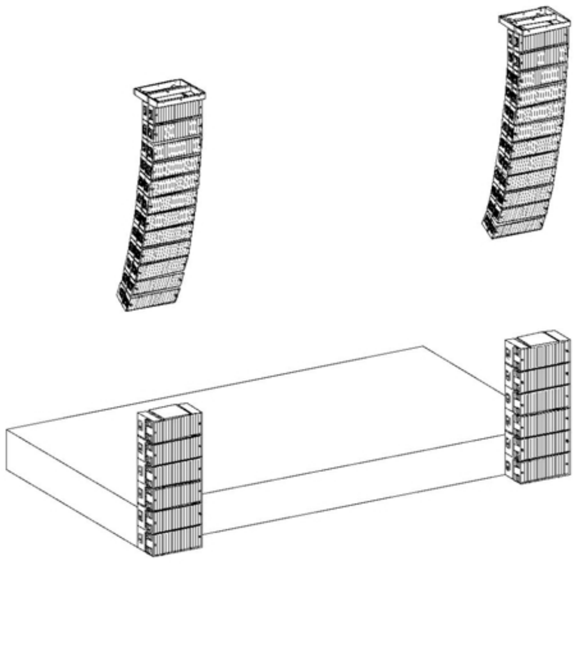
Figures 24 (a), (b) and (c) show techniques for optimizing low frequency tonal balance over the audience with a left/right configuration. In Figure 24 (a), the subwoofers are arranged in a vertical column and physically separated from the V-DOSC array. DSP presets to be used for this case have the .4W extension.

In Figure 24 (b), a center line array of subwoofers is used to augment or replace left and right vertical line arrays. Electronic arc processing can significantly improve low end coverage for a single horizontal line array configuration, especially for large scale systems when Left-Left and Right-Right arrays are added.

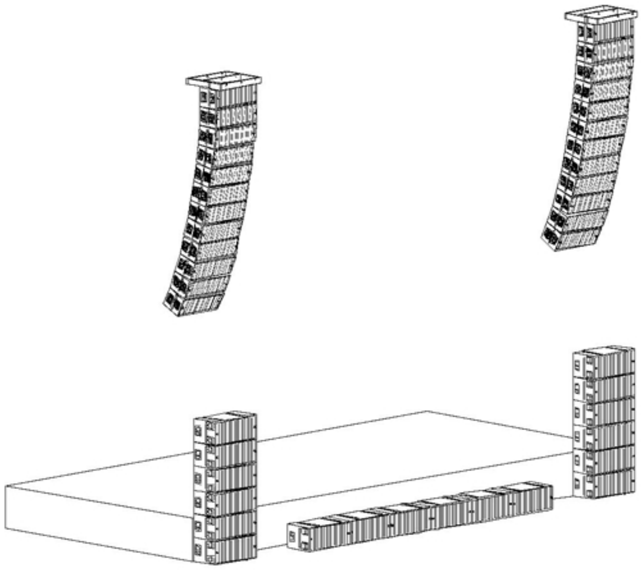
In Figure 24 (c), the subwoofers are flown directly beside the V-DOSC arrays. This configuration is a good solution to avoid the local excess of low frequency directly in front of subwoofers. DSP presets to be used for this configuration have the .X extension although 4W presets can also be used. Typically, adding several ground stacked subs per side supplies sufficient low end impact for the closest audience members.

Figure 24 (d) shows a non-recommended configuration since the horizontal subwoofer arrays (split L/R stacks) emphasize the center lobe by increasing the directivity. This is only desirable for long and narrow audience configurations.

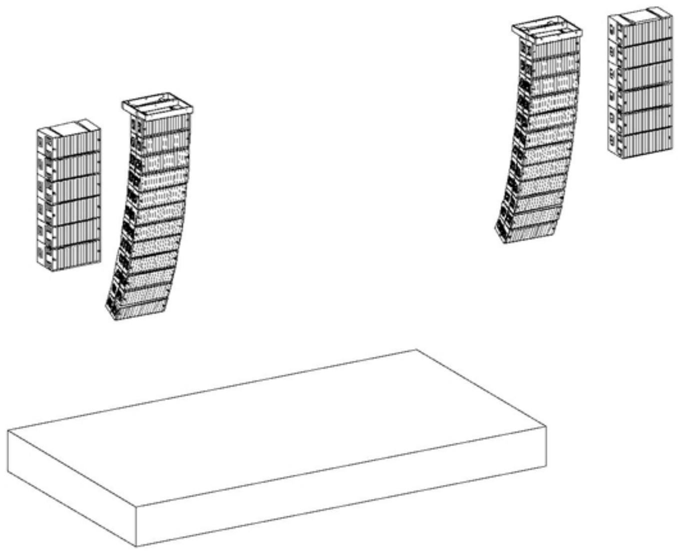
Please note that a detailed discussion of techniques for integrating subwoofers with V-DOSC follows in Section 3.4.



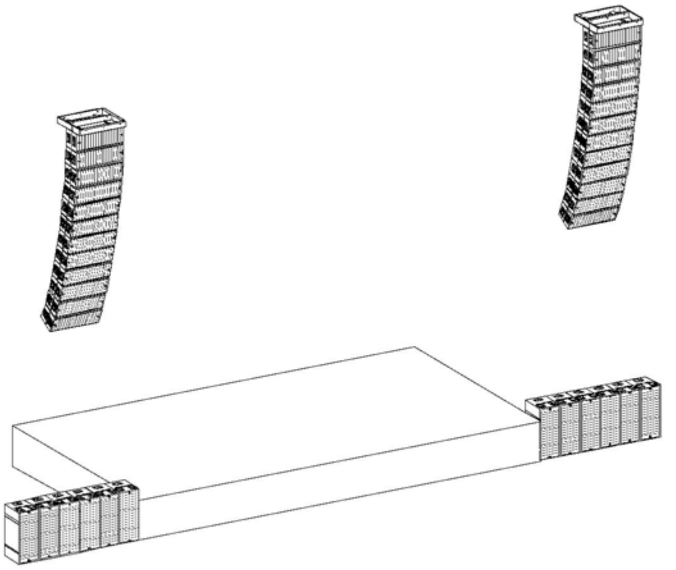
(a)



(b)



(c)



(d)

Figure 24: Illustration of Left/Right Flying Guidelines

b) Tradeoffs Between Intelligibility and Stereo Imaging

The left/right configuration has the advantage of reproducing effects of spatialization and localization. The area over which these effects is audible depends on the orientation of the left array with respect to the right array and is defined by the intersection of the isocontours for both arrays. The more the arrays are rotated or panned onstage ("toed in"), the greater the area over which "stereo imaging" is experienced. The less they are rotated onstage and the more they are aimed offstage, the less "stereo imaging" is audible. Typically, for concert applications L/R arrays are used at zero degrees or panned 2-5 degrees offstage. Experience has shown that this provides the best tradeoff between stereo imaging, evenness of horizontal coverage and reduction of the potential for build up of upper mid bass energy in the centre.

There are also tradeoffs with respect to intelligibility when aiming arrays. Psychoacoustically, improved intelligibility is obtained when the isocontours of both arrays do not overlap excessively. Provided that audience coverage is correct, intelligibility is optimal when only one array radiates on a given audience area. If two arrays are to cover a common area, intelligibility losses result when the distance separating the two arrays becomes too great. A standard distance of 20 m (65 ft) is acceptable, however, if greater separation is specified, one should avoid rotating the arrays onstage too much - this emphasizes arrival time differences between the arrays, thus degrading intelligibilty.

The decision as to whether to emphasize intelligibility or stereo imaging mainly depends on the application. New age music obviously does not require the same type of configuration as speech reinforcement!

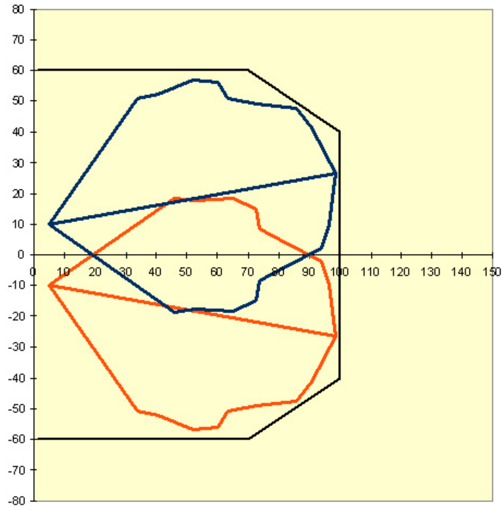


Figure 25a: Optimizing coverage and intelligibility

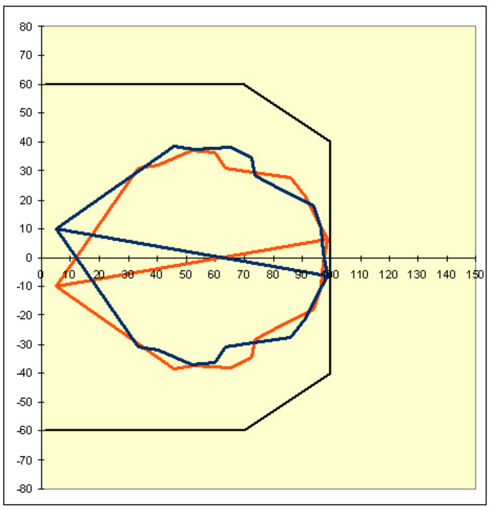


Figure 25b: Optimizing stereo imaging

3.4 SUBWOOFERS

Subwoofers are primarily used to extend the frequency response of the V-DOSC system down to 30 Hz and to increase the overall SPL without increasing the potential for audience hearing loss.

a) General Guidelines for the Use of Subwoofers

The number of subwoofers to be used depends on 3 parameters:

- Number of V-DOSC Elements: the standard number of subwoofers recommended is 1.5 V-DOSC : 1 SB218 (for example: 3:2, 6:4, 9:6, 12:8, 15:10).
- Type of Program Material: the standard subwoofer number is recommended for rock and pop music. For intense heavy metal, house music, rap or techno a 1:1 ratio is desirable; for classical music or corporate events, 2:1 is acceptable.
- Type of Venue or Installation: In open-air, when subs are ground stacked the quantity remains standard. When flown, additional subwoofers are required. Indoors, at least one subwoofer is required per 7,500 m^3 volume.

b) Combining V-DOSC With Subwoofers

In this section, we present techniques for optimizing the coupling between a V-DOSC array and subwoofers. Two cases are considered, depending on the intended purpose of the subwoofers, i.e., in some applications, subwoofers are used as an effect and are not driven with the same signal as the main system (separate auxiliary send from the console) while in other cases, the subwoofers are used as a low frequency extension of the array and are driven with the same signal in 4-way mode.

A V-DOSC array is capable of radiating frequencies down to 40 Hz at high level with good vertical pattern control due to the length of the array. Taking advantage of this capability, a V-DOSC array is usually not high-pass filtered higher than 27 Hz. When adding subwoofers to the system, part of the frequency range can overlap (depending on the selected preset), resulting in the potential for interference. Techniques for controlling this interference and maximizing the combined response of low and sub channels are discussed below for the two different cases.

c) The Subwoofer as an Effect

In this case, subwoofers are driven from a separate aux send off the console and there are several preset options. For the 4W preset, the subwoofer signal is low pass filtered at 80 Hz and the V-DOSC low section is high pass filtered at 80 Hz. Complimentary low/high pass filtering helps to avoid phase problems due to overlapping sub and low operating bandwidths so that subs can be operated in positive polarity. Excellent results can be obtained using the 4W preset, however, this solution is not recommended for high SPL applications since less low frequency energy is radiated by V-DOSC due to the 80 Hz high pass filter.

Alternatively, the X preset can be used with aux sub signal applied to input B and the sub drive signal taken from output 6 (XTA DP226 or BSS 366 processors) or output 5 (BSS 355). When the X preset is used in this way, the V-DOSC low section is high pass filtered at 27 Hz and subs operate from 27-80 Hz with negative polarity (note: this corresponds to the previously named SB preset).

NOTE: Subwoofers are usually installed on the floor, next to each other, to take advantage of the enhancement obtained due to floor coupling. However, this gain may be partly lost when the signal is shared with the flown V-DOSC array due to path length differences and phase shift. It is well-known that time alignment is only valid in one direction and that phase shift is frequency-dependent. The most critical case occurs at the low-pass frequency for the subwoofers (80 Hz) since a 24 dB per octave crossover filter generates a phase shift of 180°. At equal distance from the two sound sources, this phase shift causes cancellation when both the flown array and ground stacked

subwoofers are operated with the same polarity - this is why the sub polarity is inverted for output 5 (355) or output 6 (226, 366) of the X preset. Under these conditions, time alignment is a compromise that requires a choice as to which locations and which frequencies can support the energy losses. There are three ways to minimize these problems:

- Use the X preset (input B/output 6) which reverses the polarity for the sub channel, then optimize time alignment between low and sub channels
- Separate the input signals for the array and subwoofers (i.e., run the subwoofers off a separate drive signal using an aux send on the console)
- Physically separate the array and subwoofers by a couple of meters, then optimize the time alignment
- Add a center horizontal line array to replace or augment the split L/R subwoofer arrays.

Good results can be achieved using these recommendations provided that the low pass filter for the subwoofer channel does not exceed 80 Hz.

Note: for BSS 355 and 366, the standard X preset can be used with aux drive for subs (select Source=B for output 1), however, since subs are operated from 27-200 Hz (effective 120 Hz lowpass filter with additional channel eq) there may be subjectively too much bass information (compared with sub information) coming from the ground stacks for the closest audience members. With aux sub drive , the standard X preset has the advantage of avoiding potential phase shift problems due to overlapping crossover points and can work in virtually any situation provided that the results are subjectively acceptable.

V-DOSC 3W or 3WX presets provide another alternative for use with aux sub drive that helps to maximize the amount of low end coming from the V-DOSC system itself (with an additional margin of highpass filter protection for the low section, i.e., 50 or 45 Hz HP filtering for 3W and 3WX, respectively, versus 27 Hz for X). The 3W and 3WX presets also take advantage of L/R stereo linking. The important thing to remember is how FOH engineers work with aux sub drive - throw up the kick on the main system, make it sound good then bring it up on the aux send. It has to sum properly when the aux send is blended in so once subs are time aligned with respect to the main arrays the overall low end contour should be checked with differing aux send levels (nominal, -5, -10 etc) to make sure things respond linearly.

WARNING: Always check the polarity of the subwoofer section to optimize low frequency performance.

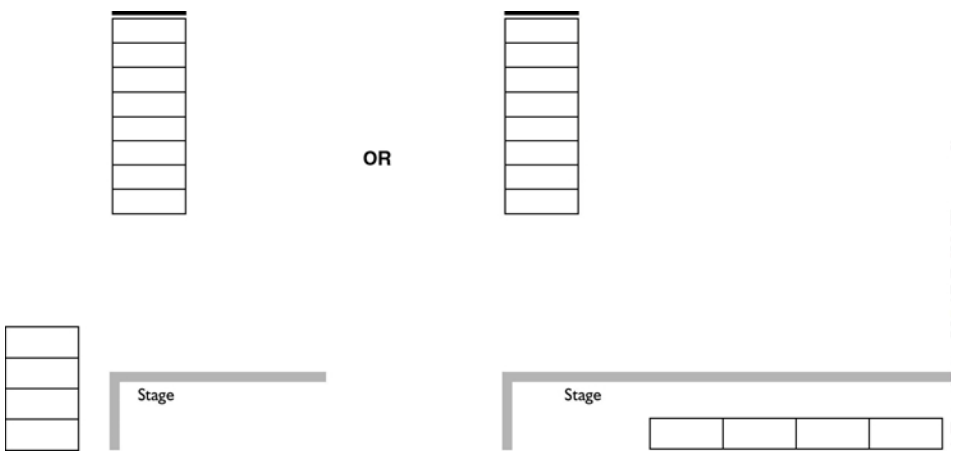


Figure 26: The SB218 as an effect. The subwoofer array and V-DOSC array are physically separated (> 6 m). Dedicated presets have the 4W suffix and 80 Hz low pass filtering is employed for subwoofers. Alternatively, the X preset can be used with input B/output 6 (XTA 226 or BSS 366) or input B/output 5 (BSS 355) or stereo 3W, 3WX presets can be employed with separate subwoofer processing.

d) The SB218 as an Extension of the Array

In this situation, the system is operated in 4-way mode and the input signal of the subwoofer is identical to that of the V-DOSC array. The 18" speakers of the SB218 and the 15" section of the V-DOSC enclosure operate over the same frequency range and identical crossover points are used in order to avoid phase shift problems. Crossover presets with the X suffix (X stands for eXtension) should be used since these presets provide dedicated equalization for low and subwoofer channels.

For 4-way operation, the operator should optimize physical coupling of the subwoofer and V-DOSC arrays. This is practically achieved by keeping the SB218 array physically close to the V-DOSC array. Two configurations are proposed:

- Fly the SB218 array on the offstage side, no more than 3 m from the V-DOSC array, axis-to-axis.
- Stack the SB218 array under, beside (offstage) or behind the V-DOSC array, no more than 3 m from the V-DOSC array, axis-to-axis.

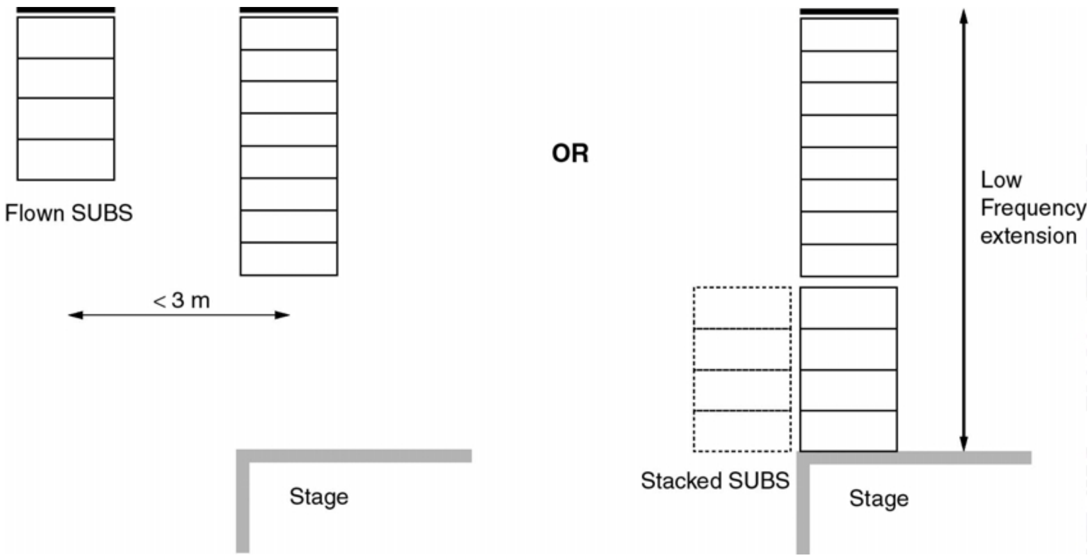


Figure 27: The subwoofer array as an extension of the V-DOSC system. Arrays are coupled to extend the low frequency response with separation or offset of no more than 3m recommended. Dedicated presets have the X suffix and 200 Hz low pass filtering is employed for the subwoofer section (effective 120 Hz LPF with additional channel eq).

In both cases, time alignment should be optimized via measurement (see Section 5.2 b). When subs are stacked underneath as an extension, this has the benefits of exceptional vertical pattern control at very low frequencies combined with perfect coupling since almost no discontinuity in low frequency radiation occurs from the top of the array to the ground.

WARNING: This set-up only works when using the correct preset. Because of the nature of the filters, the subwoofers do not sound as most sound engineers would expect. Listening to the system section by section may confuse them! It is important for the CVE to maintain control of the adjustments in order to prevent any gross errors due to misalignment. The collective performance of all speakers should normally produce incomparable low frequency far field projection.

4W presets can be also be used when subs are physically installed as an extension of V-DOSC although with 80 Hz high pass filtering there is reduced low end energy coming from the V-DOSC system itself. At the same time, there is a higher degree of excursion protection for the low section due to the 80 Hz high pass filter. Apart from these technical issues, the choice between 4W or X presets is a matter of subjective taste.

e) Flown Subwoofers

The benefits of flown subwoofers include:

- Improved low frequency summation and throw when subs are flown close to the V-DOSC arrays since the subwoofers act as an extension of the system
- Due to the longer wavelengths at low frequencies, floor coupling is still obtained with flown subwoofers. Supposed reductions due to lack of floor coupling are offset by reduced audience absorption plus the reduction of subwoofer energy for the first 20 metres is actually due to the vertical directivity that is introduced by vertically line arraying subs (not lack of floor coupling).
- Time alignment of subwoofers to the main left/right V-DOSC arrays is greatly simplified since the physical path length difference problem of ground stacked subs versus flown V-DOSC is no longer a factor that varies with listening position. Overall, this improves low frequency summation and coherency for the entire audience.
- Elimination of local low frequency buildup for the audience down front in the first few rows. Adding several ground stacked subs per side or a centre line will provide sufficient low end impact for the first 20 metres.
- Cleaner staging and better sightlines.

f) Central Location, Ground Stacked

This configuration optimizes the radiated energy. All subwoofers are acoustically coupled, and the floor, if solid (concrete, for instance), acts as a mirror and virtually doubles the number of subs. Given the same number of subs, the overall pressure obtained by ground stacking in this manner is simply not achievable in any other configuration.

The central ground stack solution is not devoid of shortcomings. Typically the problems are as follows:

- Tonal balance has an exaggerated low boost for the closest members of the audience. Locating front fill (apron fill) loudspeakers close to the subwoofers can help offset this.
- Low end can spill back onstage and cause feedback problems for the stage monitoring system
- Restricted projection due to audience absorption and modified thermal conditions (this problem is likely to occur with any ground stacked configuration)
- Mutual radiation pressure may wear the drivers located at the center of the array

For the central ground stacked configuration, the subwoofers are not acoustically coupled with the main V-DOSC arrays. They are processed separately, and are fed with an independent signal from an auxiliary output. See section c) for a description of preset options and sub drive processing.

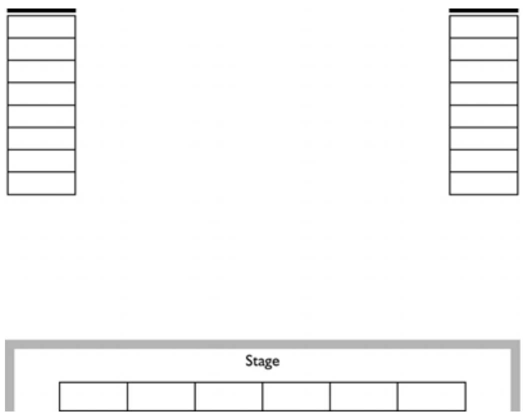


Figure 28: Central location, ground stacked subwoofer configuration.

g) Electronic Delay Arc Processing

For large scale applications, an interesting technique for controlling the central ground-stacked horizontal line array is to use delay processing to electronically arc the array. Cabinets are grouped in blocks of four symmetrically about the central axis and the delay is progressively increased for offstage groups. Electronic arcing in this manner can successfully decouple sections of the array so that tonal balance is improved up close while at the same time bass coverage is smoother throughout the audience. For a single horizontal line of subs, SUB ARC presets are provided for all digital processors to provide a useful starting point.

Delay arc processing is also useful for larger systems involving LL, L, R and RR arrays with associated vertical subwoofer line arrays in conjunction with a central horizontal line array (see Figure 24). To date, it has been found that the optimum arc radius is equal to half the length of the central line array. Delay taps are calculated geometrically based on this arc radius and the physical distance of a given subwoofer group off the center line reference (y-axis). An EXCEL spreadsheet tool to perform delay and offset calculations is available in ARRAY (SUB ARC). The LL and RR subwoofer line arrays are then time aligned to the central horizontal line by taking measurements on their main aiming axis.

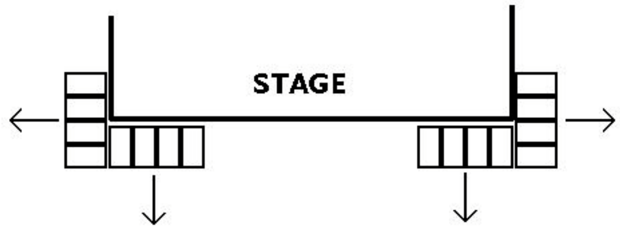
In practice, the center subwoofer group acts as the time reference – T1 is applied to compensate for any offset due to physical placement and to include predelay for time alignment of the subwoofers with the instrument backline, kick drum, monitor sidefills or monitor front line as desired. The predelay T1 is then added to the calculated relative arc delays T2, T3 and T4 in order to maintain the electronic subwoofer arc. L-L and R-R arrays are delayed by T4+T1; L and R arrays are delayed by T3 + T1 to maintain proper alignment with their respective subwoofer arrays.

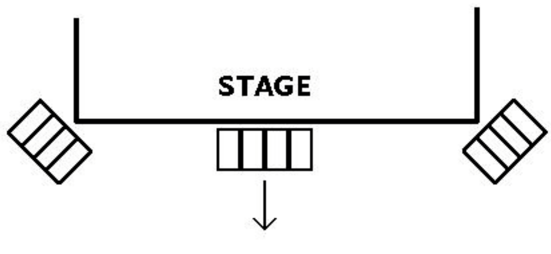
It is recommended that arc radii remain shallow so that the difference between T3 and T4 remains less than 15 msec. Steeper arc radii will decorrelate L-L and L V-DOSC arrays to the extent that the L-L array will be perceived as an echo with respect to the L array. Apart from smoother low frequency coverage, electronic arc processing of the main arrays has the added benefit of improved stereo perception since psychoacoustically such processing helps to localize the audience's attention towards the stage not the nearest speaker array.

Since they are used as an extension of the flown V-DOSC systems, subwoofer arrays for L-L, L, R and R-R can be low pass filtered at 200 Hz (X preset) while all central subwoofers are low pass filtered at 80 Hz. Experiments are ongoing at L-ACOUSTICS to determine optimum arc radii and subwoofer array configurations for various applications.

h) Other Techniques for Reducing Centre Buildup

Apart from electronic arc processing of a single centre line of subwoofers, two other techniques are illustrated below. For the case of L/R arrays that are wrapped around stage corners, the idea is that by directing energy of the individual L/R sub arrays offstage, reductions of the centre buildup are obtained. For the case of the LCR sub array, L/R arrays are oriented at 45 degrees offstage (for the same reason) and instead of a single buildup between L/R arrays as for L/R split stacks, with an LCR array there are "mini buildups" between L/C and C/R that also help to smooth out the centre buildup.





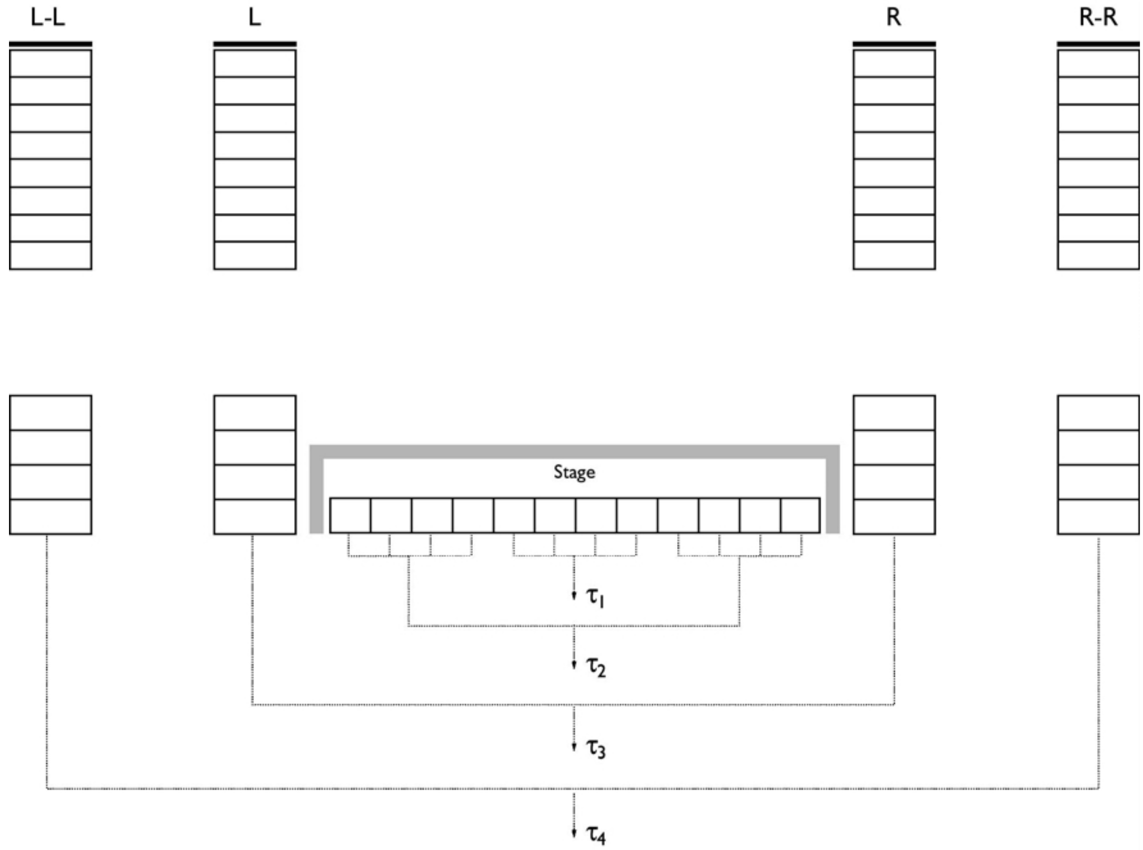


Figure 29: Subwoofer configuration with electronic arc processing.

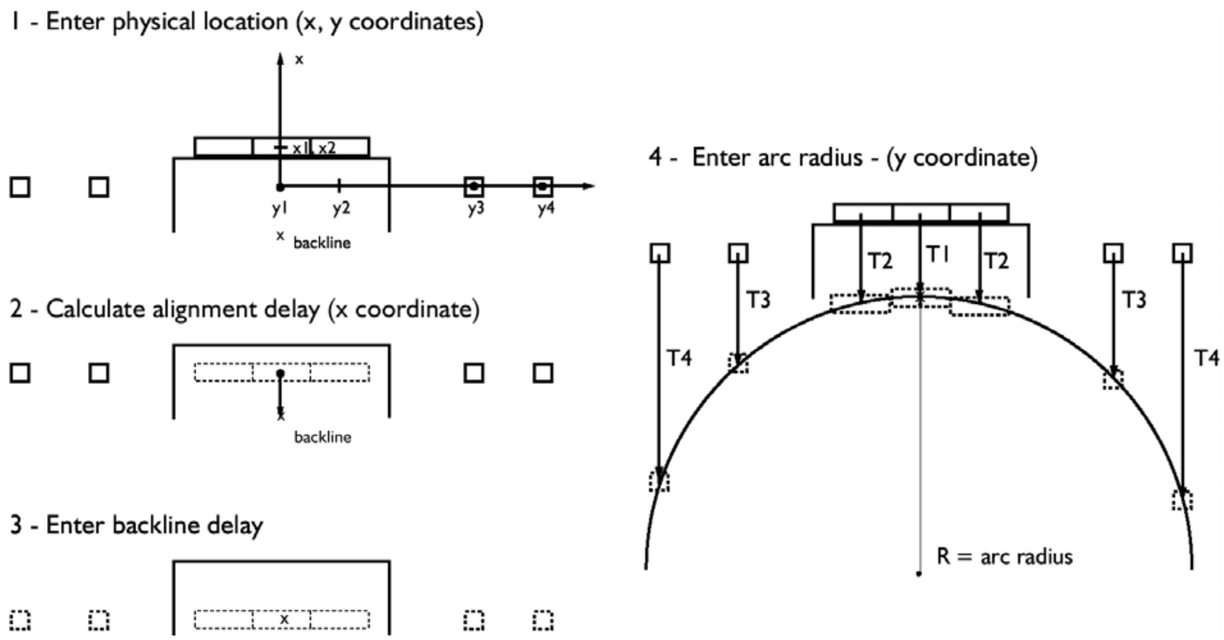


Figure 30: Terminology for the SUB ARC Sheet in ARRAY

3.5 DELAY SYSTEMS

The use of V-DOSC in FOH applications provides exceptionally broad coverage over distances that simply cannot be reached with traditional systems. This is a major benefit of the WST approach.

Table 10: SPL Comparison: Conventional System versus V-DOSC Operating in Cylindrical Mode

DISTANCE	Conventional System A-weighted SPL	V-DOSC (cylindrical) A-weighted SPL
10 m	110 dB	110 dB
25 m	102 dB	106 dB
50 m	96 dB	103 dB
100 m	90 dB	100 dB
200 m	84 dB	97 dB

As seen in Table 10, the excellent longthrow capability of V-DOSC can oftentimes eliminate the need for a delay system. In addition, the mix position can be located as far away as 80 m (250 ft) from the stage without problems for the FOH engineer. However, some external conditions such as physical obstacles, wind, sound wave refraction due to temperature and humidity gradients or very large distances (>150 m) may create the need for a delay system - typically in open-air situations.

The use and tuning of delay systems in open-air situations is far from straightforward since the correct delay time setting is typically valid only over a limited area. In addition, wind, temperature and humidity variations along with other random phenomena can affect the speed of sound, thus invalidating the delay time settings.

a) Delay System Installation

There are a few principles that should be applied when installing delay systems:

1) Avoid installing delays wherehe adjustments cannot be made secure (use security panels or password protection whenever possible).

2) Overdelaying up to 15 ms is acceptable due to the Haas effect and may provide a safety margin. Greater than 15 ms is not acceptable since the delayed sound will be perceived as a distinct echo behind the main signal. In some situations (speech), it is advised to underdelay in order to optimize the off-axis intelligibility and clarity behind the delayed system.

3) Spread different sources, with different delayed waves, instead of grouping them in a single location. This allows for broader coverage by the delayed sources and produces more homogeneous SPL over the delay-covered area. If possible, physically locate the delay positions along an arc with a radius equal to the distance from the furthest offstage delay position to the stage.

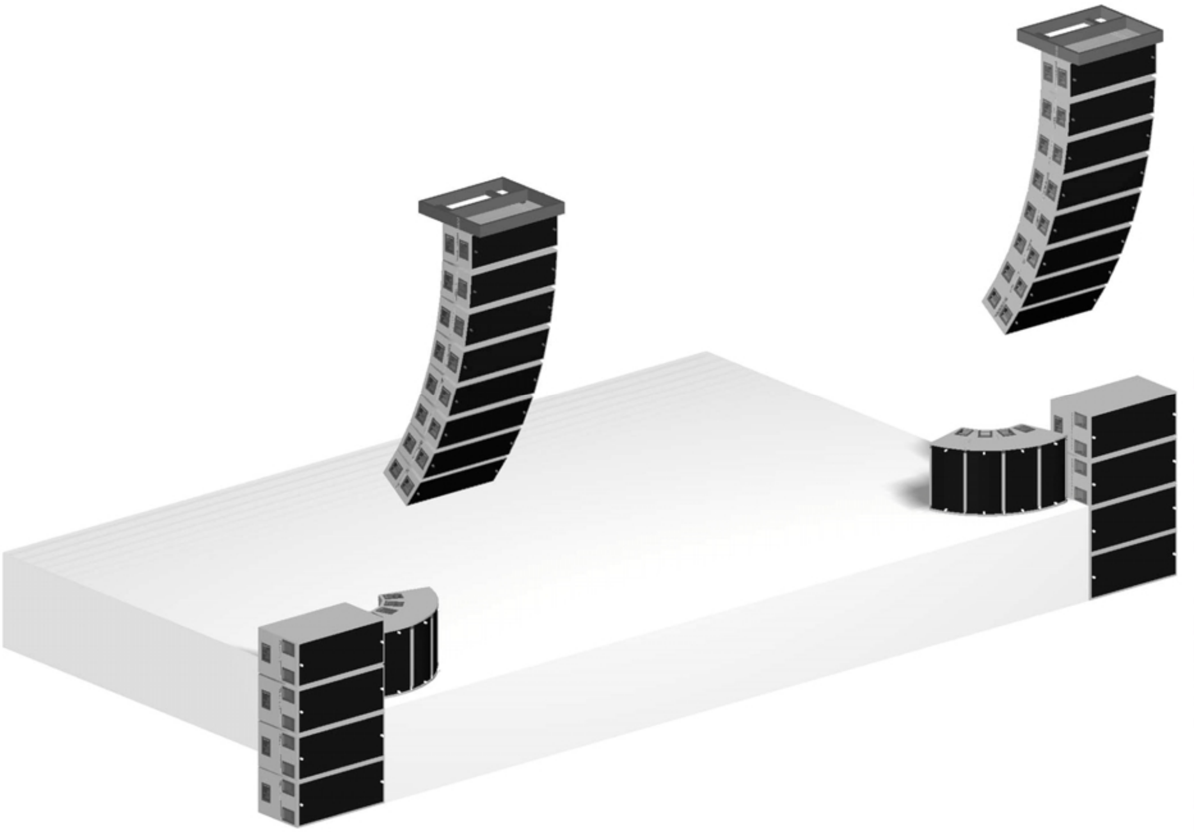
4) Focus the main LL, L,R and RR V-DOSC arrays to a distance of 130-150 metres and locate delay positions at 100-120 metres with focus starting from 120-140 metres, i.e., allow for 10-20 metre overlap between main array and delay system coverage.

5) Time-alignment of delays should be made on the axis of the reference source and the delayed source. At a measurement point on this axis, if the setting of the delay is such that the two sound waves arrive exactly at the same time, the reference source will be ahead of the delay source at any other place off this axis. Time domain based measurement equipment is essential for setting delay times (see Section 5.2 regarding measurement procedures). Alternatively, Bushnell Yardage Pro rangefinder binoculars can provide a good starting point.

3.6 SAMPLE ARRAY CONFIGURATIONS

Suggested array configurations are presented below for a variety of applications. These examples are meant to provide a good starting point for detailed array design. Installation parameters such as exact number of elements, array height and element angling should be calculated using ARRAY on a case-by-case basis.

a) Long & Narrow Audience Format (flat)



HORIZONTAL ISOCONTOUR

rated at 102 dB A-weigted
or 114 dB SPL

	A1	A2	A3	A4
Elts number	**12**	**12**		
dBV input	**4**	**4**		
X (m)	**5**	**5**		
Y (m)	**-9**	**9**		
Azimut (°)	**5**	**-5**		
Headroom	5	5	9	9

AUDIENCE

CONTOUR 1 X	CONTOUR 1 Y	CONTOUR 2 X	CONTOUR 2 Y
0	**30**		
30	**30**		
100	**30**		
100	**0**		
100	**0**		
100	**0**		
100	**0**		
100	**0**		

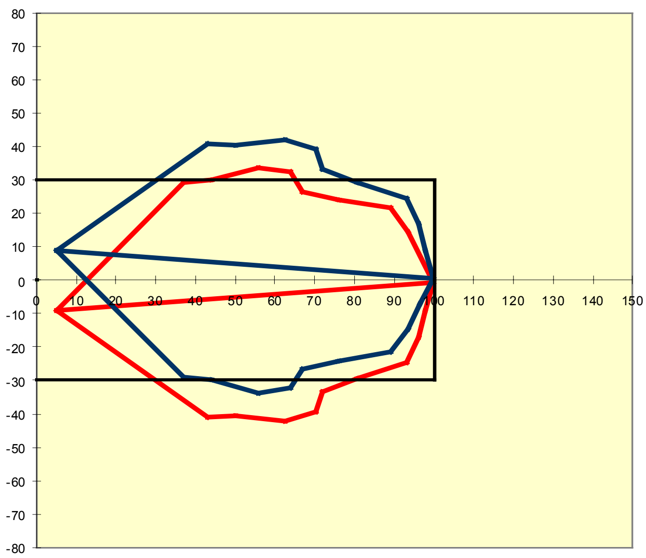
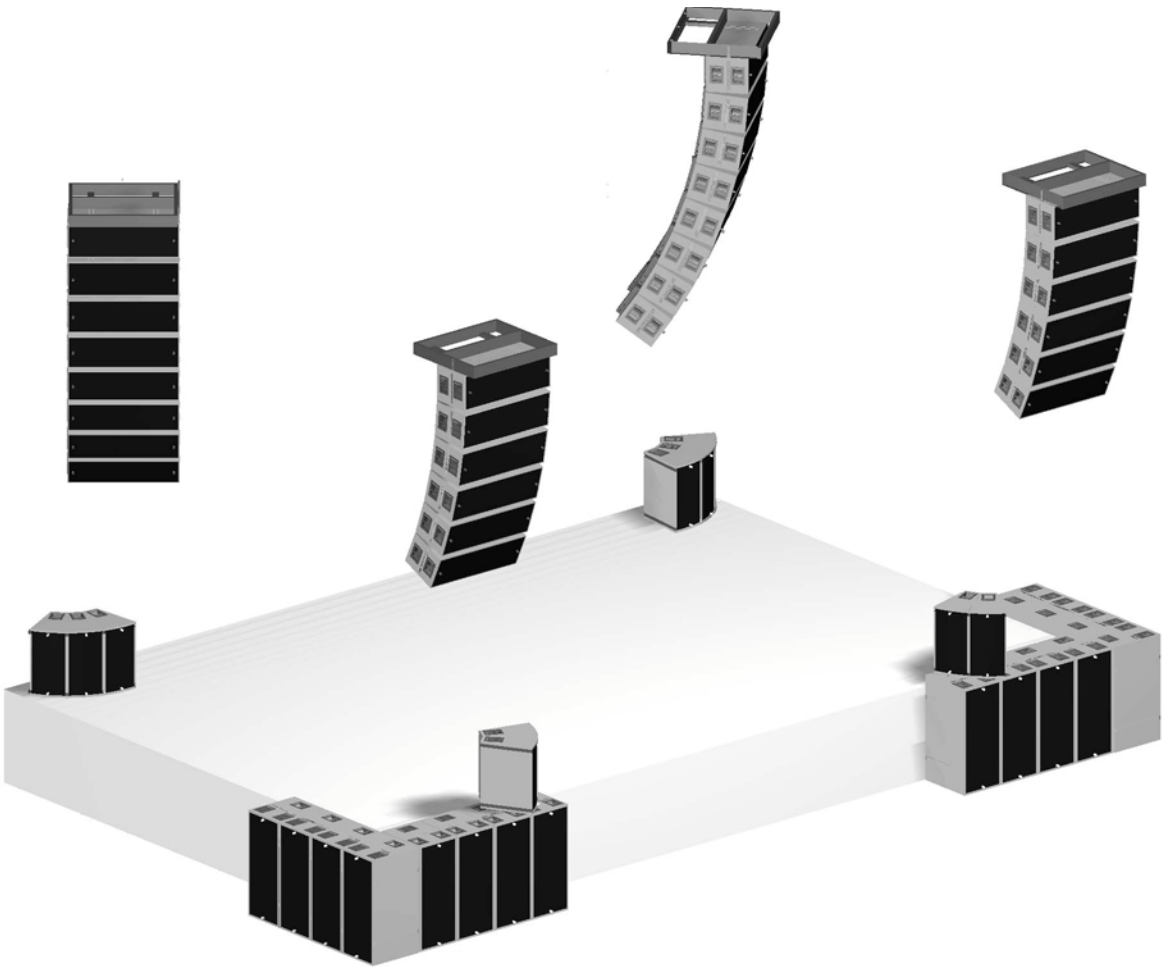


Figure 31: Long & Narrow Audience Format (flat)

b) Wide Audience Format



HORIZONTAL ISOCONTOUR

rated at 102 dB A-weigted
or 114 dB SPL

	A1	A2	A3	A4
Elts number	6	6	8	8
dBV input	4	4	4	4
X (m)	15	15	5	5
Y (m)	-9	9	-12	12
Azimut (°)	0	0	-40	40
Headroom	5	5	5	5

AUDIENCE

CONTOUR 1 X	CONTOUR 1 Y	CONTOUR 2 X	CONTOUR 2 Y
0	60	0	10
60	60	15	10
60	0	15	0
100	0	15	
100	0	15	
100	0	15	
100	0	15	
100	0	15	

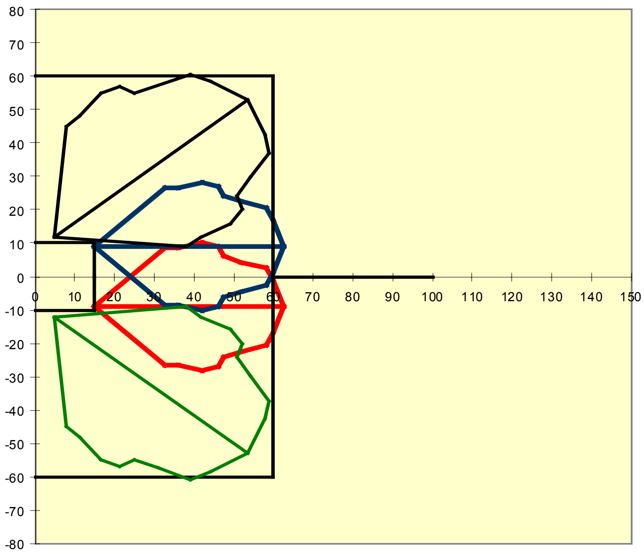
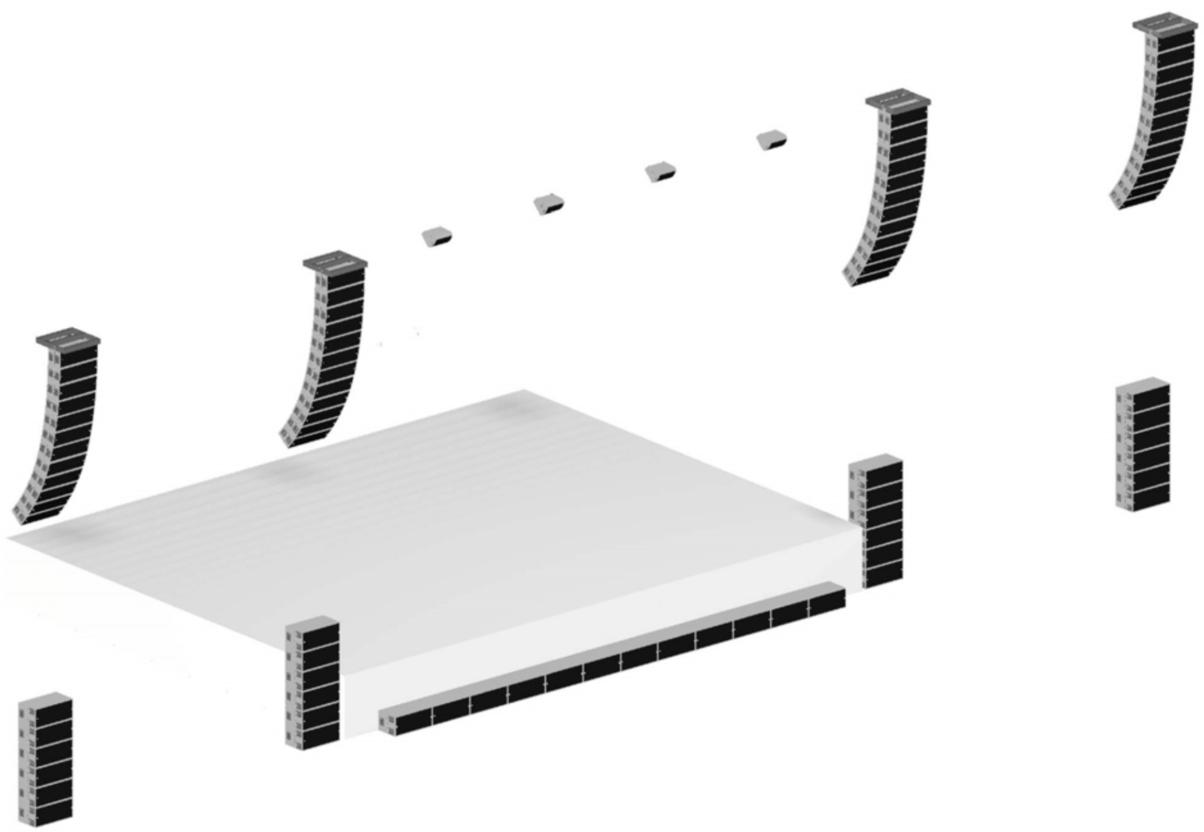


Figure 32: Wide Audience Format - Foxwoods Casino Installation

c) Stadium or Large Scale Outdoor Festival Format



HORIZONTAL ISOCONTOUR

rated at 102 dB A-weigted
or 114 dB SPL

	A1	A2	A3	A4
Elts number	12	12	12	12
dBV input	3	3	3	3
X (m)	15	15	15	15
Y (m)	12	-12	37	-37
Azimut (°)	0	0	0	0
Headroom	6	6	6	6

AUDIENCE

CONTOUR 1 X	CONTOUR 1 Y	CONTOUR 2 X	CONTOUR 2 Y
0	80	0	15
100	80	15	15
100	30	15	
100	0		
100	0		
100	0		
100	0		
100	0		

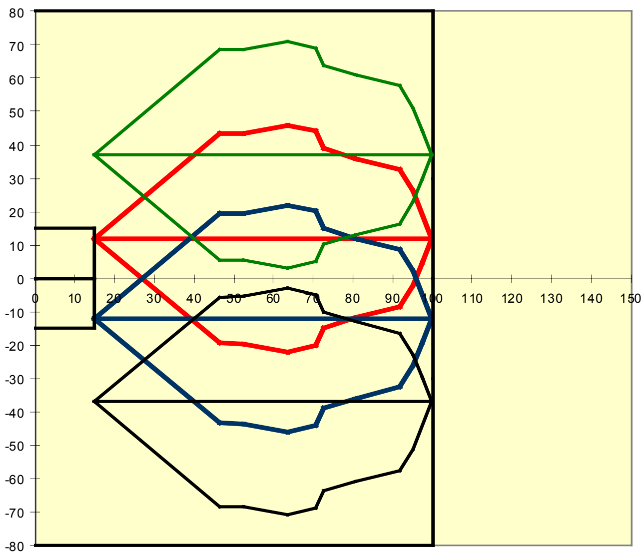
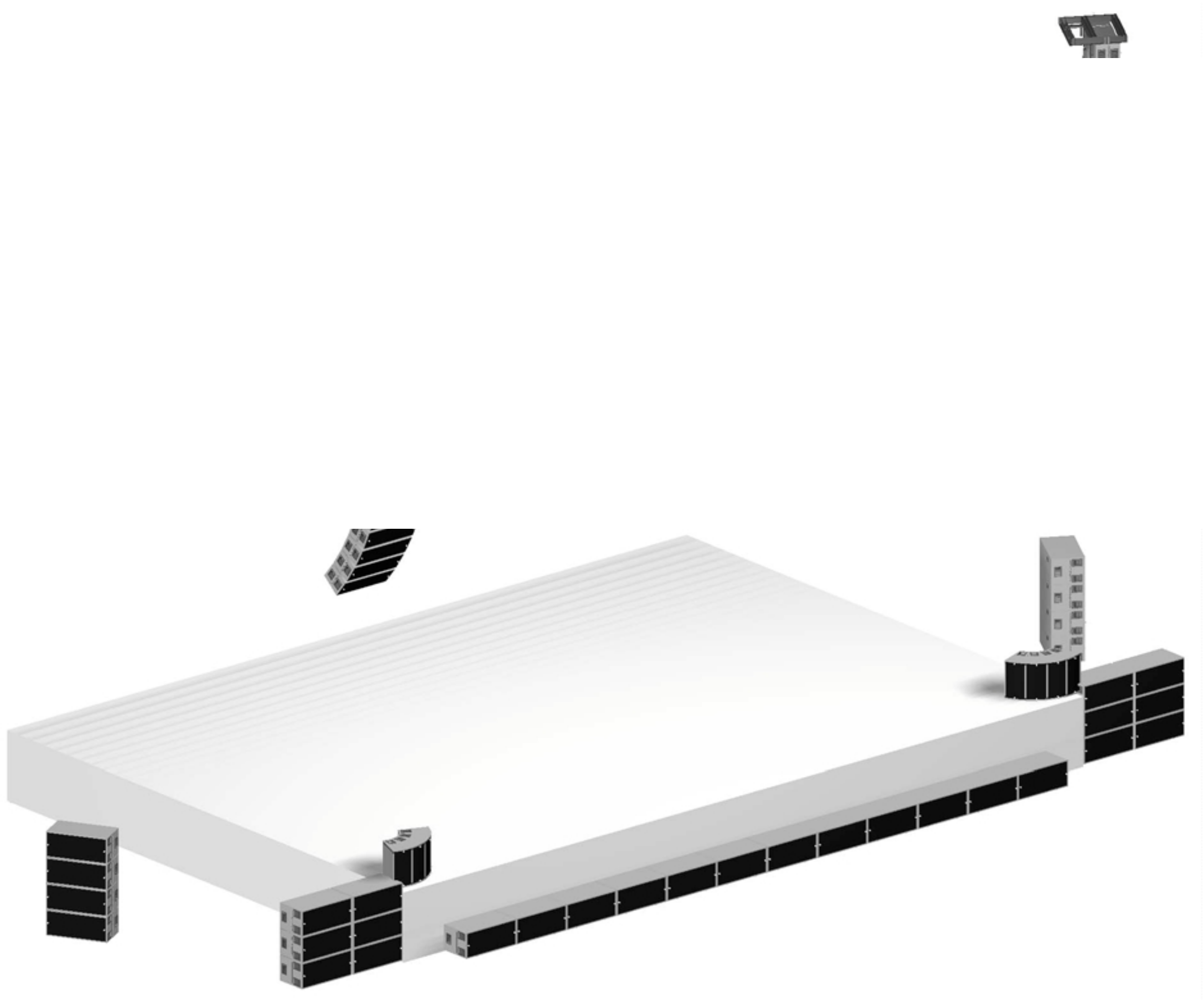


Figure 33: Stadium or Large Scale Outdoor Festival Format

d) Arena Format (Steep Slope)



HORIZONTAL ISOCONTOUR

rated at 102 dB A-weigted
or 114 dB SPL

	A1	A2	A3	A4
Elts number	**12**	**12**	**6**	**6**
dBV input	**4**	**4**	**4**	**4**
X (m)	**15**	**15**	**11**	**11**
Y (m)	**12**	**-12**	**20**	**-20**
Azimut (°)	**0**	**0**	**40**	**-40**
Headroom	5	5	5	5

AUDIENCE

CONTOUR 1		CONTOUR 2	
X	Y	X	Y
0	**60**	**0**	**15**
80	**60**	**15**	**15**
110	**30**	**15**	
110	**0**		
130	**0**		
130	**0**		
130	**0**		
130	**0**		

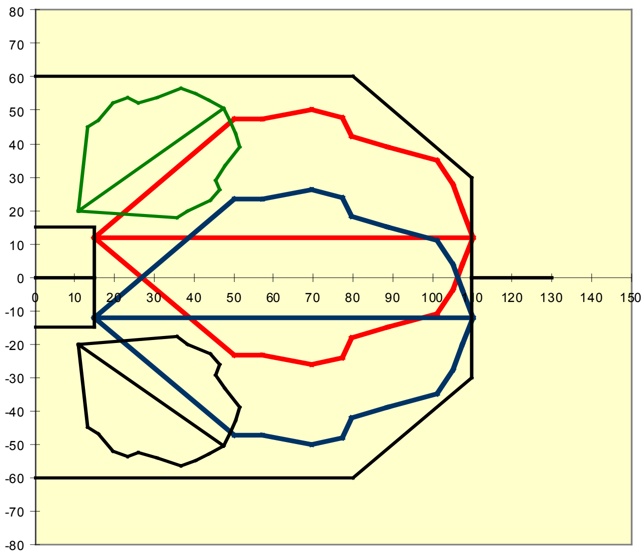


Figure 34: Arena Format

e) Invisible Configuration - System Located Behind the Stage

(Originally designed with Alain Courieux for opera performances)

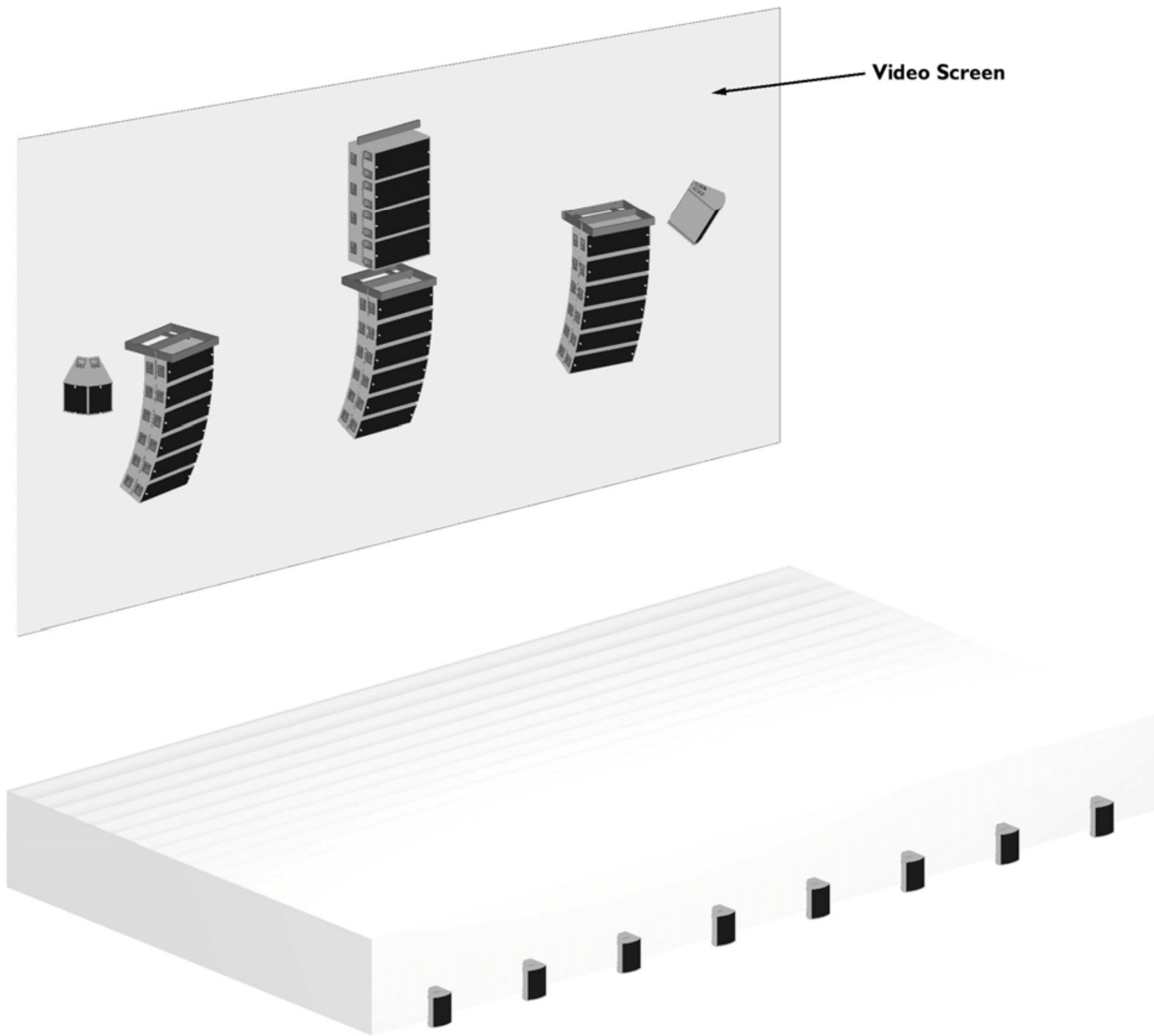


Figure 35: System Behind the Stage

4. INSTALLATION PROCEDURES

In the following sections, detailed installation procedures for stacking and flying V-DOSC are presented. Please follow these procedures carefully and at all times remain safety-conscious.

4.1 STACKED SYSTEM

a) Stacking and Connecting

For stability reasons, the maximum number of V-DOSC elements that can be stacked is 6. In this case, each screwjack presents a load of 350 kg. The strength of the supporting floor should be carefully examined to determine if such a load can be supported - sheets of plywood or steel plates can be placed under individual screwjack feet in order to help distribute the load.

Generally, two people can comfortably build a 4 high stack - for 5 or 6 high, a forklift is useful.

Once the floor location for the stacked array has been determined, the BUMPER is placed in the desired location, oriented upside down so that the two rotating legs on the BUMPER are free to swing upwards. Lower the height adjustment blocks on all four screwjacks to the minimum position. Mount the screwjacks on all four corners of the BUMPER by sliding the screwjack height adjustment blocks into the locating slots on the BUMPER and then lowering the screwjacks.

Note: In some cases the front (or rear) pair of screwjacks can be omitted and the front (or rear) of the BUMPER laid directly on the stacking surface for added stability.

Aim the BUMPER in the correct direction to provide the desired amount of array rotation on- or off-stage. Then raise the BUMPER at least 8 cm off the floor by rotating the screwjack wheels (CW = up, CCW = down). This clearance is necessary so that screwjack wheels will not physically interfere with the dolley locator pins on the front of the bottom V-DOSC enclosure.

Referring to the simulation results obtained using ARRAY, the screwjacks are then adjusted to provide the required vertical angle for the lowest element. NOTE: A digital protractor or analog inclinometer is essential for performing angle measurements. For stability reasons, the maximum bumper tilt angle is 12 degrees. It is important that the centre of gravity of the array remains within the footprint of the BUMPER, i.e., with reference to the Gravity Abcissa value in the Mechanical Data cells of Array 2000, this value should be > -0.42 m and < 0.63 m.

The lowest element is then rolled up to the BUMPER while still on its dolley. The dolley is unlocked, then the element is lifted and placed on the BUMPER with the two rotating legs oriented upwards (as a reference for cabinet orientation, stacking runners on the cabinet should be on the bottom and the rear V-DOSC logo in the correct orientation). Adjust the front-to-back position of the enclosure on the BUMPER by aligning the Aeroquip flytrack sections of the enclosure and the BUMPER.

Mechanically connect the first element to the BUMPER by lifting the rotating legs of the BUMPER up and locking them into the rear rails of the V-DOSC element using the U pins. Verify the tilt angle for the first element using a digital protractor or analog inclinometer (use the stacking runner recess on top of the cabinet for alignment of the measurement tool) and perform any required tilt adjustments using the screwjacks.

A second V-DOSC element is then stacked on top of the first and mechanically connected using the rotating legs and U pins in the same way. The two elements are then connected using the desired ANGLE straps and two SPACER blocks are tightly wedged in-between the first and second elements to remove all slack in the ANGLE straps - this sets the correct tilt angle for the second element. Never use a single SPACER block in the center of the cabinets – the wood thickness is only 15 mm at this point and the overall weight of the stack could cause damage to the bottom enclosures. Verify the tilt angle for the second element using a digital protractor or analog inclinometer and perform any necessary adjustments.

NOTE: Since the rear edges of the cabinets are touching when enclosures are stacked, this introduces an additional 1degree for ANGLE straps when cabinets are stacked versus flown (i.e., 5

mm = 1 degree). The relationship between ANGLE strap value and stacked angle is tabulated below:

Table 11: Angle Strap Values

ANGLE COLOUR CODE	ANGLE STRAP LABEL	NOMINAL FLOWN ANGLE	NOMINAL STACKED ANGLE
Gold	BUMP	1.6	N/A
Yellow	0.75 / 5.5	0.75 / 5.5	1.75 / do not use
White	1.3	1.3	2.3
Red	2	2	3
Blue	3	3	4
Green	4	4	5

This means that ANGLE strap values should be selected by taking into account the additional 1 degree difference for stacked versus flown. For example, if ARRAY 2000 simulations indicate that a 4 degree angle is required between elements 1 and 2, select a 3 degree angle strap for actual installation. Angle tolerances can also arise due to small variations in enclosure construction and SPACER block placement. Use your measurement tools (digital protractor or angle inclinometer) to determine the effect of these tolerance variations and to minimize their impact.

The same procedures are followed for all other elements of the array until stacking is completed. NOTE: it is easier to place SPACER blocks between elements as the array is built instead of inserting them afterwards.

The correct angle for the entire array is obtained by fine adjustment of the BUMPER screwjacks. Focus can be checked easily by sight - looking from the rear of the array through the small space between the top element and the second one, the lower wall of the top element should be aligned so as to aim towards the rearmost seats of the audience. Alternatively, from the highest section of audience area, if you can see the upper wall of the top V-DOSC element, you are out of the coverage pattern. More precise aiming can be accomplished by placing a laser pointer or similar device on the upper wall of the top enclosure. A similar visual check can also be made with respect to the lower wall of the bottom element of the array to ensure that closest members of the audience are covered.

Connection of the array to the AMP RACKS can be performed as soon as stacking is complete. To avoid confusion, connect cables to the AMP RACKS first and parallel jumpers between V-DOSC elements last – this way, reversal of cable sex is avoided (i.e., the output of the rack is female, which can be confusing to the average stagehand). Remember to parallel 3 V-DOSC elements maximum.

When unstacking the array, first remove all loudspeaker cabling. As each V-DOSC enclosure is unstacked, remove the SPACER blocks first since this makes it easier to remove the U shaped locking pins when disconnecting the rotating legs. Dolley boards can be attached and enclosures directly unstacked onto their wheels.

b) Safety Rules

CAUTION: NO MORE THAN 6 V-DOSC ELEMENTS SHOULD BE STACKED TOGETHER ON ONE BUMPER. INSTABILITY CAN OCCUR EITHER WHEN TILTING THE ARRAY OR UNDER HARD WIND CONDITIONS. ALWAYS USE ANGLE STRAPS BETWEEN ENCLOSURES.

Always test the strength of the supporting floor - each screwjack may bear up to a 350 kg load. Use plywood sheets or steel plates under individual screwjack feet in order to help distribute the load.

The maximum downward or upward tilt angle of the bumper is 12 degrees.

When stacking on scaffold platforms for delay towers, omitting the front 2 screwjacks and ratchet strapping the BUMPER to the platform can improve stability.

4.2 INSTALLATION OF A FLOWN SYSTEM

a) Flying and Connecting

Flying a V-DOSC array is fast and easy. When properly prepared and organized, handling time can be significantly reduced (especially in comparison with conventional systems). Installation is optimum when 3 people are available (16 V-DOSC can be flown in 20 minutes!) although it is possible for 2 people to fly V-DOSC. Please refer to the sequence of photos shown in Figure 36 with respect to the following description of flying procedures.

Preliminary Preparations:

- All geometric data for the flying the array (i.e., bottom element elevation, inter-element angles, site angles) has been pre-calculated using ARRAY 2000 and mechanical data has been checked for safe rigging conditions
- Two independent flying points are available, one behind the other with a spacing of 1.05 meters (43 ¼") between points and with the desired onstage rotation angle for the array. Alternatively, three points can be used along with a swivel shackle connecting a delta plate to the rear BUMPER point for pan adjustment of the flown array
- Each flying point should be equipped with a chain motor of 0.5T for a 4-element array, 1.0T for a 5- to 10-element array, 2.0T for an 11- to 16-element array
- Access is available beneath the flying points, i.e., a flat surface where it is possible to roll V-DOSC elements into position – preferably from behind the flying location but it is possible to fly when boxes are lined up perpendicular to the fly points (eg. from the floor along the front of a stage)

Given the above conditions:

The first step is to line up all the elements at the flying location (while they are still face down on their dollies). As a reference for cabinet orientation, the stacking runners for the element that is to be at the top of the array should be visible at the flying location. Looking down the line of enclosures from the flying location, the V-DOSC logos on the rear of all cabinets should all be in the correct orientation. Once flown, the rear panel logos are upside down. (see Fig 36 a)

The elements are then mechanically connected together using the rotating legs and U pins. Use the locking safety pins to secure all U pins in place. (see Figs 36 b-e)

Next the BUMPER is placed at the top end of the array. The BUMPER is mechanically connected to the top cabinet in the same way that the cabinets are joined together, i.e., by rotating the BUMPER legs into position on the top enclosure and locking them into place using U pins. (see Fig 36 f-g)

Connect the top element to the BUMPER using two BUMP ANGLE straps. This locks the top element to the BUMPER (NOTE: the angle for the top element is set by angling the BUMPER during the final step of array angle adjustment – this is the site angle of Element 1 as specified in ARRAY 2000, not the autofocus adjust angle). (see Fig 36 h)

Referring to the ANGLE strap values that have been predetermined using ARRAY 2000, proceed to connect one end of all ANGLE straps to the flytrack sections on both sides of all elements of the array (except for the bottom element). Available ANGLE straps are: 0.75, 1.3, 2, 3 and 4 degrees - by moving a 0 degree ANGLE strap one hole location closer, 5.5 degrees is obtained.

Although exact flytrack hole location is irrelevant since the length of the ANGLE strap bar actually controls the angle between enclosures, as a convenient reference you can place ANGLE strap fittings so that the shackle is located in flytrack location 3.

Orient the ANGLE straps so that the ring end of the fitting is facing to the left (down once cabinets are flown) and the fitting is located at the left side of the flytrack (bottom of the flytrack section once flown) in flytrack hole position 3 from the end.

If ANGLE straps are connected with the text out it is convenient to perform a last minute check to confirm that all values are correct. In addition, when the array is flown, all ANGLE strap labels will be visible from the rear - this is useful and makes for a cleaner installation. (see Fig 36 i)

Connect all elements to the AMP RACKS using V-CABLEs and V-LINK jumpers between elements for parallel operation (NOTE: it is best to connect cables from the AMP RACKS to the cabinets first and jumpers last in order to avoid cable reversal). Longer cables can be routed over the BUMPER or secured using a spanset then velcro straps or tape used to secure cables to the U pins for strain relief. (see Fig 36 j-l)

Route two ratchet straps through the U pins of the bottom enclosure and over the bumper. Orient the ratchet strap so that the ratchet handle is accessible from the top (outside once flown). (see Figs 36 m-n). Note: as an alternative to ratchet straps, SPACER blocks can be employed. (see Figs 36 i-iv). As a general rule, ratchet straps are acceptable when the system is pointing downwards, spacer blocks should be used when the system is pointing upwards.

Remove all dolley pins. As the array is flown, the cabinets will automatically lift off the dollies. (see Fig 36 o, q)

Conduct a final inspection to make sure all cabling is correct, correct ANGLE straps are in place and securely seated in the flytrack, all U pins are fully inserted and all U pin safeties are locked in place.

Attach the rear chain motor to the rear BUMPER fly point using a shackle. (See Fig 36 p)

Do not connect the front chain motor yet – this can be done once the first few cabinets are flown.

Note: For added safety factor when flying large arrays, bridling should be employed. For bridling, 2 steel slings are attached to the outer points on the bumper using shackles then joined using a pear ring for attachment to the motor (requires 2 steel slings, 4 shackles, 1 pear ring per point).

With three people available, one person runs the chain motors while the other two attach ANGLE straps (and insert SPACER blocks) as the array is lifted. Stagehands can be assigned the tasks of steadying the array from behind, providing necessary cable slack, and removing/stacking dolley boards.

With one person on either side of the array, raise the rear chain motor. The first element is rigidly attached to the bumper and other elements of the array bend automatically since they are connected by the rear pivoting legs. When the first element leaves the ground stop raising the array. Note that the dolley boards automatically fall off as the cabinets lift off (see Fig 36 q).

The front motor is lowered so that the front fly point on the BUMPER can be mechanically connected to the chain motor (see Fig 36 r).

Note: A 1 m (3 ft) steel extension (stinger) is required for the front (downstage) motor attachment point in order to prevent the motor chain bag from hanging down in front of the array.

Raise the front motor to the same height as the rear motor to level the BUMPER.

Attach the laser and/or remote inclinometer on top of the first V-DOSC element

The two people on either side of the array then use the side handles to lift the second V-DOSC element up towards the first element, allowing them to connect the ANGLE straps from the first element to the second element. (see Fig 36 s,t).

Note: If the rear motor is raised slightly higher than the front motor, this will tend to close the cabinets automatically, making it easier to attach ANGLE straps. As a reference, attach ANGLE straps from flytrack hole 3 to hole 3 between cabinets to provide the correct interelement spacing. When using the 0.75 degree angle strap to obtain 5.5 degrees, attach the straps from flytrack hole 3 to 2.

Always make sure you have a solid physical mating between the double stud fitting and the flytrack - do not hold the plunger out - simply place the fitting into the flytrack then slide the fitting into positon and listen for a loud "click". Physically shake the ANGLE strap to ensure that a secure physical connection has been obtained.

Optional: SPACER blocks can also be inserted on each side by attaching the hook and safety on the bungee cord between cabinet handles then pushing the SPACER backwards towards the rear of the enclosures so that they are tightly wedged in between the boxes and all slack is taken out of the ANGLE straps.

Note: Ratchet straps or SPACER blocks are required since as elements are added to the array, the weight of the array tends to flatten the aiming angles of individual enclosures. SPACER blocks help to maintain the correct interelement angles.

The array is progressively raised and this procedure is repeated until all ANGLE straps (and SPACER blocks) have been connected to all elements.

Note that up to 8 dolley boards can be stacked according to the technique shown in Fig 36 u.

It is a good idea for someone to guide the array from behind as the system is flown (the rotating legs on the bottom cabinet are useful as handles for this purpose). Pay particular attention to steady the bottom element as it lifts off since it will want to flip forwards. (see Fig 36 v).

Before taking the system to trim, float the array off the ground in order to tension the rear ratchet straps (See Fig 36 w,x). Mounting a remote digital inclinometer on the top element and using a handheld digital inclinometer for the bottom element is the most accurate technique for matching the physical installation to what was simulated in ARRAY 2000. Essentially, we want to adjust the ratchet straps so that the installed array has the correct Vertical Coverage Angle (Cell P36 in ARRAY 2000).

- With reference to the remote inclinometer readout, pretilt the array so that the top element is angled according to the Site #1 that was simulated in ARRAY 2000 (Cell I24). Pretilting is important so that the ratchet straps will be tensioned while the array is in the final focus orientation since changes in centre of gravity for the array (due to changes in Site Angle #1) will affect interelement angles.
- Using a handheld inclinometer on the bottom element, tension the ratchet straps so that the bottom element site angle is equal to the Site Angle #N in ARRAY 2000 (where N= the number of elements). This procedure gives you exactly the Vertical Coverage angle for the array that was simulated in ARRAY 2000.
- When the system is taken to trim, Site Angle #1 will have to be readjusted using the remote inclinometer readout or with reference to the laser (see below) since chain motors do not run at exactly the same speed.

Note: DO NOT OVERTIGHTEN THE RATCHET STRAPS, especially if the array is tilted upwards. The goal is to simply take the slack out of the ANGLE straps. Overtightening the ratchet straps can increase the angle between enclosures up to 1 additional degree per cabinet (the gap at the rear of the enclosures closes, similar to a stacked system).

b) Trim and Angle Adjustments

At this point there are only two adjustments left, i.e., the trim height of the array and the tilt angle of the first element. The rear motor is used to set the proper height of the whole array. Controlling the tilt angle is performed by the relative action of both two chain-motors, i.e., once the proper height has been set, activating the front motor upwards or downwards varies the tilt angle.

NOTE: Always fly the array without tilt initially. Applying tilt before the array is entirely flown can produce excessive stress on ANGLE strap fittings – especially if excessive upwards tilt is applied. Once flown, the maximum upwards tilt is approximately 5 degrees - always refer to the mechanical data provided in ARRAY 2000 to confirm that rigging limits are not exceeded .

Depending on the tools available, there are a number of possible techniques for trimming and angling the array.

For trim height measurement, one end of a tape measure can be fixed to the bottom wall of the bottom element, at the rear of the enclosure, by using some duct tape. The tape measure is then

used to raise the array to the proper height (based on the geometrical data which was pre-calculated using ARRAY) and can be pulled loose afterwards.

Under dark conditions (indoors), a small flashlight can be attached at the junction between the top and the second elements. The final trim angle adjustment is checked from the rearmost seats of the audience: when the light can be seen through the gap separating the first and the second elements, the angle of the array is correct.

Under daylight conditions (outdoors), the trim angle can be visually checked from the rearmost audience section (flashlight not required). If the gap between the top and second elements is clearly visible then the focus is correct. Note: Bushnell Rangefinder glasses can also be useful for checking gaps between cabinets at long distances. Coverage up close can be checked by visually checking to see that the top wall of the bottom enclosure is in line with the desired aiming angle for the closest members of the audience. For final angle adjustments, a pair of radios is useful while one person walks the room and visually inspects the array while a second person operates the motors.

A more precise technique is to use a laser pointer or laser level attached to the top of the first element. Trim angle adjustments are then given by the focus of the laser on the audience (no walking to the back of the venue is required although a set of binoculars can be useful in locating the laser beam). Coverage up close can be checked by attaching the laser device to the lower wall of the bottom enclosure. Obviously, array focus using lasers is difficult to perform outdoors under daylight conditions.

As described above, mounting a remote digital inclinometer on the top element and using a handheld digital inclinometer is very useful for tensioning ratchet straps and verifying that the overall vertical coverage angle of the array matches what was simulated in ARRAY 2000. Once the system is flown to trim, the tilt of the array can be set using the remote inclinometer and setting the tilt = Site Angle #1. It is important to perform this final adjustment once the array is at the correct trim height since chain motors typically do not run at exactly the same speed.

For all of the above alternatives, several pieces of string or light rope can be run from the floor, over the BUMPER and to the Maglite, laser device or remote inclinometer in order to pull the instrument free and lower it after measurements have been performed. As a final check, mute mid and low channels and run pink noise through the system and listen to the high section coverage throughout the venue to verify that installation is correct.

If a DELTA PLATE is used, on- or off-stage rotation of the entire array can also be adjusted. Three motors are used in this case, and a rotating shackle connects the DELTA PLATE to the BUMPER. Together, the two rear motors control the height of the array and the relative action between them controls the rotation. As before, the front motor controls the tilt angle.

Use the above described techniques to verify that L and R arrays are matched (plus L-L and R-R arrays, if installed).

Important things to note concerning the use of ratchet straps:

Tightly ratcheting flown arrays is not recommended for the following reasons:

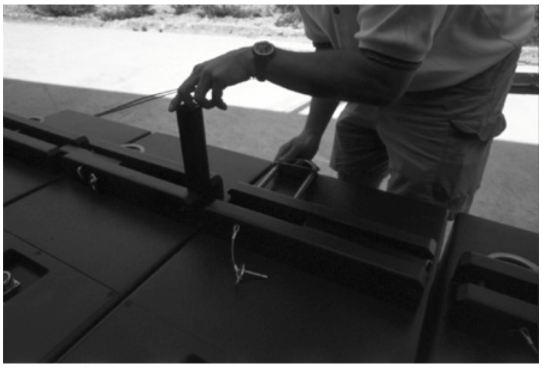
- Ratcheting increases the angle between flown enclosures up to an additional 1 degree (i.e., a 4 degree ANGLE strap can produce 5 degrees, etc)
- This increase in angle can be non-constant vertically along the array and is difficult to predict or control (typically the bottom elements are affected first)
- A 5.5 degree ANGLE strap can be modified to a 6.5 degree value with tight ratcheting and WST criteria will <u>not</u> be satisfied
- When ratchet straps are overtightened and the array is excessively tilted upwards, physical damage can result to the flytrack and/or ANGLE strap fittings (see above)
- L-ACOUSTICS has developed a SPACER block to eliminate the need for use of ratchet straps, (specifically for the case of arrays with upwards tilt)

Moderately ratcheting flown arrays IS recommended for the following reasons:

- Ratchet straps introduce a continuously variable "tweak factor" that allows for fine tuning of coverage down front and greater ANGLE strap resolution when used correctly
- When the array is pointing downwards, the centre of gravity shifts backwards and the top V-DOSC elements tend to close naturally, forming a flat long throw section (this is desirable for flat audience, open air festival situations). For larger 12-16 element arrays, even though 0.75degree ANGLE straps are used for the first 6-8 elements, the actual obtained angles will be close to zero (with no ratchet) when the system is flown and the top element focussed downwards. Moderate ratcheting then introduces the possibility of continuously variable angles between 0 to 0.75 degrees and the progression is monotonic as a function of height. For example, if a 16 element array is pointing 4 degrees down and 0.75 degree straps are used for the first 8 elements (combined with moderate ratcheting), actual values on the order of 0, 0, 0.25, 0.25, 0.5, 0.5,0.75, 0.75 will be obtained for elements 1-8. This provides better spacing of element impact zones over the audience in flat open air situations.
- When the array is pointing upwards, the centre of gravity shifts forwards and V-DOSC elements tend to open naturally, providing the nominal ANGLE values (0.75, 1.3, 2.0, 3.0, 4.0 and 5.5). Therefore, for a V-DOSC array with upwards tilt, <u>very little ratchet strap tension is required</u>. Typically, the bottom 2-3 elements will need to open up slightly and SPACER blocks should be used for this purpose (or moderate ratcheting).
- The most precise way to work with the ratchet strap is to have a remote inclinometer on top of the array to measure Site Angle #1 and a handheld digital inclinometer to measure the bottom element site angle. Fly the array using the ANGLE strap values calculated in ARRAY 2000 and float the array above ground level at a height where the ratchet strap handle is accessible. While referring to the remote inclinometer, adjust the front/rear motors to give the correct Site #1 angle that was calculated in ARRAY 2000. Allow the array to settle then measure the site angle of the bottom element. Adjust the tension of the ratchet strap until the site angle of the bottom element agrees with the value determined in ARRAY 2000. At this point, the vertical coverage of the array is correct and agrees with the VERTICAL COVERAGE parameter that was simulated in ARRAY 2000. Next, take the array to the calculated trim height (or bottom element elevation) that was determined in ARRAY 2000. Since front and rear chain motors can run at different speeds, once you are at trim, you must reset the focus angle of the array using either the remote inclinometer or by referring to the laser. Repeat this process to ensure that the vertical coverage and focus of Left and Right arrays are exactly matched.

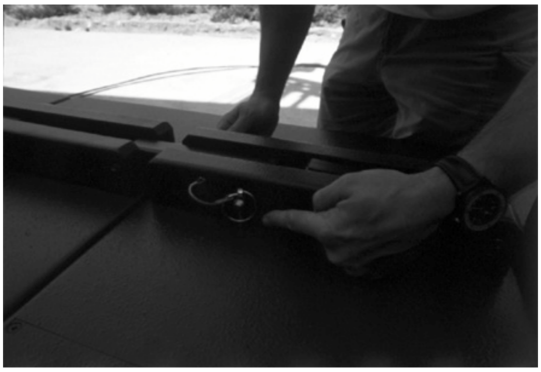
(a)

(b)



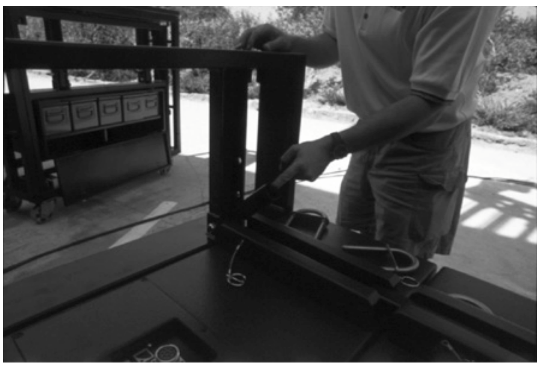
(c)

(d)



(e)

(f)



(g)

(h)


(i)


(j)


(k)


(l)


(m)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(o)


(p)

(q)

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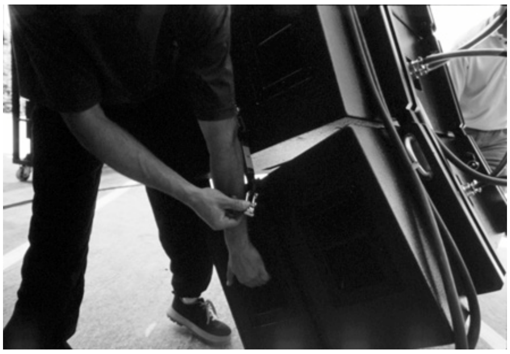
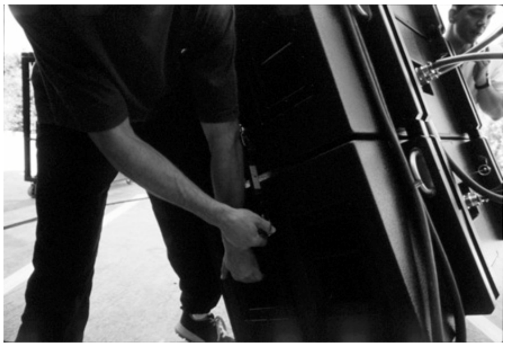


(s)



(t)

(u)

(v)

(w)

(x)

(y)

(z)

(i)

(ii)

(iii)

(iv)

Figure 36: Photo sequence showing the steps involved in flying V-DOSC

c) Flying Amplifier Racks

In some situations, it is desirable to fly amplifier racks behind the V-DOSC array. Shorter speaker cable runs have the advantage of lower cable resistance resulting in more effective signal transfer since there is less energy dissipated as heat in the cable. Reduced cable runs can also improve damping factor and potential frequency-dependent losses due to the skin effect (in extreme situations). Remote control and monitoring of amplifiers is highly recommended for flown amplifier rack installation for obvious reasons. Currently, there are no provisions for flying amplifier racks off the V-DOSC BUMPER – a separate fly point is required and you should be careful to observe safe rigging practices according to your given situation.

d) Safety Rules

CAUTION: THE FLYING SYSTEM IS RATED FOR A MAXIMUM OF 16 V-DOSC, 15 V-DOSC + 3 dV-DOSC or 14 V-DOSC + 6 dV-DOSC. DO NOT FLY ANY MORE THAN THIS NUMBER OF ELEMENTS FROM A SINGLE BUMPER ASSEMBLY.

All rigging should be performed by certified, trained rigging experts. Proper chain motor installation and operation is absolutely necessary under all circumstances. L-ACOUSTICS recommends the use of safeties at all times.

Chain motor ratings for each fly point are as follows:

0.5T motor per point for a 4-element array;

1.0T motor per point for a 5- to 10-element array;

2.0T motor per point for a 11- to 16-element array.

For additional safety factor, bridling using two steel slings, four shackles and one pear ring (front and rear) is recommended when flying 11-16 element arrays.

Always refer to the MECHANICAL DATA cells in ARRAY 2000 to ensure that safe rigging conditions apply to the designed system before installation.

Always be sure that the immediate area is clear of people and obstacles whenever raising or lowering the array. Announce (in a loud voice) whenever the array is being moved to get people's attention. Always look up while moving the array to be sure that movement remains unimpeded and to check cable tension. Once flown to trim and correctly angled, remove motor control cables so that the array cannot be tampered with by unauthorized people.

Always cover motors with plastic in outdoor installations where motors may be exposed to rain.

ANGLE straps are required at all times. When V-DOSC arrays are flown with no tilt on the BUMPER (and top element) all weight is borne by the rear pivoting legs. However, as the array is tilted upwards, weight is also borne by the ANGLE straps. The more the array is tilted upwards, the more weight is carried by the ANGLE straps. For this reason, never tilt the array upwards by more than 5 degrees. For the same reason, always fly the array flat, then apply tilt once all cabinets are flown.

Never overtighten the ratchet straps, especially if the array is tilted upwards.

5. V-DOSC SYSTEM OPERATION

WARNING: The V-DOSC system is capable of producing high sound pressure levels. Hearing loss or damage can occur with prolonged exposure to high SPLs. Please operate your system responsibly at all times. An SPL meter on the mix console is highly recommended as a reference.

Prior to describing system operation and tuning procedures, subjective criteria are first considered in order to discuss the objectives of system setup.

5.1 SUBJECTIVE LISTENING AND TONAL BALANCE

The overall tonal balance of the system depends on both the musical program and on the target SPL (Leq or average SPL). For large scale rock concerts, typical sound pressure levels reach 105 dBA continuous (A weighted) and 125 dB SPL peak. The only harmless way to reach such levels is to increase the low end since significant increases in the A-weighted SPL would eventually become painful for the audience (and illegal).

In general, low and high frequency contours result in a more mix-friendly system for modern music – however, the influence such a system contour has on your board tapes is a completely different topic for discussion. To a large extent, response contours are a matter of subjective taste and personal preference that is related to where the mix engineer prefers to set his mix balance – on the channel strip or on the main PA. Some engineers prefer a built-in low end bump in the PA, others prefer a flat system and using the “warmth of the channel strip” on the console. Cultural differences can also be a factor as European audiences in general tend to prefer less bass than in the USA.

For program material with lower overall level requirements (speech and classical music, for instance), alteration of the traditionally "flat" tonal balance by boosting the low end is not desirable since peak levels occur only during very short musical transients and the Leq is much lower – typically 95 dBA, or less. In fact, a prominent bass response would not be accepted from an artistic point of view by most classical performers and music directors (for nominal flat response, mid/high ratios will have to be scaled up by approximately 8 dB or the low/sub channels attenuated).

Since V-DOSC and dV-DOSC presets have been specifically engineered to provide an excellent starting point for system tuning, it is always a good idea to set the desired ratios between high, low and sub sections via simple attenuation and subjective listening before proceeding to perform detailed measurements and equalization. Typically, for 12-16 element V-DOSC arrays the mid and high sections should both be increased by 3-6 dB to compensate for the enhanced low frequency coupling that occurs in larger arrays.

The frequency response, for all presets, is flat between 300 Hz and 4 kHz. At higher frequencies, the response is either flat or has a high frequency shelf of approximately 6 dB according to the selected preset (i.e., smooth or bright, LO or HI, respectively). Between 40 Hz and 160 Hz, a low frequency contour of approximately 10 dB is built into the preset. Practically, array coupling and room-related effects will require equalization in the range of 160 Hz to 300 Hz. Any other equalization will be the result of the engineer's subjective choice.

Due to the evenness of coverage afforded by dV-DOSC and V-DOSC, equalization adjustments made at the mix position typically translate well throughout the audience. Due to system coherence, 2 dB changes on a graphic equalizer are dramatic. When properly installed, room-related effects above 300 Hz are minimized and system performance translates well from venue to venue. Essentially, the dV-DOSC and V-DOSC systems serve as an accurate reference monitor, allowing the FOH engineer to concentrate on the fine details of his mix.

A common problem with FOH engineers who are not familiar with V-DOSC and dV-DOSC is the tendency to over-equalize the midband section since they are not accustomed to the nearfield listening experience over this frequency bandwidth. The CVE accompanying the V-DOSC or dV-

DOSC system should attempt to dissuade over-equalization and educate the guest engineer whenever possible. A better solution is not to equalize the mid band section but to simply reduce the level of vocals etc in the mix.

Several strategically placed parametric notches can be highly effective in compensating for room reverberation modes. For performing this equalization, use the parametric filters available on the inputs of the digital processor for higher resolution (not the graphic). In a festival situation, an effective approach is to perform basic equalization using the input parametric filters then turn the system over to the guest FOH engineer with house graphic eqs set flat. Typically, guest engineers are more comfortable with a graphic eq for quick adjustments on the fly. After each act, the graphic can be reset for the next engineer.

System predelay is commonly used to improve the combined integration of the main FOH system with the sound coming from onstage. In addition, system predelay can also be effective in improving overall gain before feedback. In some cases, alignment with the instrumental backline (guitar amplifier stacks, kick drum) is effective and the distance can be determined using simple geometry. In other cases, time alignment with the drum monitor, monitor sidefills or the monitor front line may prove more effective. Generally, the loudest element on stage makes for a good time reference. In smaller venues where the monitor system energy reflects off the back wall and roof, then interferes with the energy generated by the band itself and then with the main PA, system predelay is not as straightforward and the best results are obtained subjectively.

Predelay can be applied before or after performing the detailed measurements outlined in the following section – just be sure that the correct relative delay is also applied to your subwoofers and to fill arrays and downfill systems.

Finally, many users have reported good results when using program compression/limiting on the main mix, i.e., before the digital processor inputs. Using a high quality compressor/limiter (eg SSL, dbx 160S, XTA SIDD or other high quality equivalent) and just a touch of compression, e.g. 1-2 dB with a 1.5 to 2 ratio, this allows the mix to "sit better on the system" and prevents transients from "jumping out of the mix". In addition, by calibrating the limiter threshold to the digital processor clip point, this provides an additional level of system protection by preventing digital clipping of the processor inputs. Program compression/limiting before the processor inputs also provides another level of control when dealing with "over zealous" guest engineers in a festival situation…

5.2 MEASUREMENT PROCEDURE

Tuning and equalization of a V-DOSC system is a relatively simple procedure, i.e., given the prediction tools and array design concepts outlined in Chapter 3, the precise flying/stacking procedures described in Chapter 4 and dedicated digital processor presets, an excellent starting point for system tuning is immediately obtained upon installation.

Generally speaking, little equalization is required and one third octave real time analysis (RTA) is sufficient for equalization measurements. Alternatively, TDS, MLSSA, SIM, SMAART or Spectrafoo analysis can be used to obtain higher resolution or for time delay measurements.

When properly installed coverage should be very homogeneous and 3 measurement locations are sufficient for system tuning: one in the near audience area, one at the mix position and one at the rear of the audience. It should be verified that the global shape of the frequency responses at these locations is similar before proceeding to perform detailed equalization.

a) Measurement Caveats

Interpreting measurements correctly requires awareness of a few pitfalls. Here are some typical ones:

- Measurement of one source is meaningful. Measuring two sources radiating the same signal simultaneously creates interference due to path length differences, dramatically altering the

frequency response. In such cases, the RTA display is misleading. Some analyzers (RTA 1 from Sound Technology, for instance) provide two de-correlated independent pink noise outputs. This allows for simultaneous measurements on a Left/Right system while avoiding path difference interference effects.

- Positioning the measurement microphone on a stand at a typical height of between 1-2 m (3-6 ft) produces a measured frequency response with a dip in the low-mid frequencies. This is due to acoustic cancellation between the direct wave and the reflected wave from the ground which arrives a few milliseconds later. This dip in the frequency response is not due to the system and should not be equalized. This can be checked by performing a second measurement where the microphone is placed on the floor and comparing the results. More sophisticated measurement systems such as TDS and MLSSA allow the user to apply a time window to remove reflections from the measurement, however, this is can be at the expense of low frequency resolution.
- For the above reason, when there is no physical obstacle acting as a barrier between the source and the microphone, it is always preferable to place the measurement microphone on the floor. If the floor is absorbent (for example, grass in open-air situations) the measured response may display a high-frequency loss – this does not correspond to reality. In this case, a sheet of plywood can be useful for reducing the effect of this on your measurements.
- For the same reason as for floor reflections, the measurement microphone should not be placed close to any reflecting surface (a road case with the lid open and an absorbing blanket placed just below the microphone can help absorb the first reflection).
- Equalizing a subwoofer system is the most tricky part of the tuning procedure since measurements taken at a single location can be misleading. Indoors, there are room modes to consider and you may be located in a pressure null or maximum depending on the location and the frequency. Always be sure to verify the effect of your adjustments throughout the audience.

b) Step-By-Step Tuning Procedure

In general terms, the installation and tuning procedure should go as follows:

Room Dimensions ⇒ ARRAY 2000 ⇒ System Install ⇒ System Focus

Preset Selection ⇒FOH Drive Rack/CO24 Channel Assignment

System Check ⇒ Coverage Check ⇒ Time Align ⇒ Balance ⇒ Tune

1) Confirm the installation by following the trim and angle adjustments outlined in Section 4.2 d).

2) Send pink noise to each array (one array at a time, band by band) and have an assistant spin up each amplifier channel one at a time. For all bands, turn up amp channel 1 then amp channel 2 to confirm that there is acoustic summation. Then turn down amp channel 1and turn up amp channel 3 and again confirm acoustic summation. Repeat the process (i.e., 1 and 2, 2 and 3, 3 and 4 etc) until you have checked all amp channels and all bands for each array. If you encounter a polarity problem, use a polarity checker to isolate the problem.

3) Verify coverage by running low level pink noise through the system (excluding subwoofers) and walking the room. Check the coverage down front and at the back of the venue. Perform any required trim and angle adjustments if necessary.

4) Using your preferred measurement system, at the mix position, compare Left versus Right frequency response, channel by channel, as a final system check. All responses should be identical within 1 dB, except for the high band where larger deviations are acceptable (2 to 3 dB). Beware of wind effects which can dramatically affect your measurements.

5) Typically, the subwoofers act as an overall time reference for the complete system so the next step is to time align the subwoofers to the main arrays.

If a time domain measurement system (MLSSA, TDS, SIM, SMAART or SpectraFOO) is not available, use a laser rangefinder to measure the geometric difference between the main array and the subs. Adjust the subwoofer delay to correspond to the geometrically determined delay as a starting point.

- Place a microphone on the floor, halfway between the mix position and the rear of the audience, equidistant between the Left and Right Arrays
- Mute the highs and mids
- Individually feed the low channel of the main arrays then the subwoofers with pink noise and adjust the crossover output levels to obtain the same measured level.
- Invert the sub polarity
- Feed subs and lows with pink noise and fine tune the delay adjustment by up to +/- 5 msec (from the geometric delay) to obtain maximum cancellation
- If varying the subwoofer time delay has no effect then change the crossover preset and adjust the delay to provide maximum cancellation
- Reinvert the polarity of the subs and confirm that maximum summation is obtained

If a time domain measurement system is available, a good trick to get better time resolution for subwoofer arrival time measurements is to increase the lowpass filter from 80 or 200 Hz to 5 kHz (don't forget to put it back when you're finished!).

6) Check the overall tonal balance of one side - select the correct preset and perform basic band attenuation using crossover output level adjustments (sub, low, mid, high ratios) to achieve the desired tonal balance. Record the result and store it in an available memory location.

Note: For larger arrays (12-16 elements), due to increased coupling of the low section, mid and high section outputs should both be increased by 3-6 dB in order to achieve correct spectral balance. Simple attenuation is generally all that is necessary – do not reach for the graphic equalizer first! Keep in mind that the best frequency response is not necessarily a flat line from 20 to 20k Hz (see the above discussion on tonal balance).

7) Duplicate settings for the other side and verify that both sides are the same.

8) Measure the Left, Right and Left+Right response at the mix position and store the result.

9) Measure the Left, Right and Left+Right response at several representative locations - e.g. closer to the system (equidistant between Left and Right arrays and within the defined coverage pattern) and at the rear of the audience. Store the results. This is often difficult in open-air situations since wind conditions can have an influence on the measurements. A windscreen for your microphone can help – make sure you are aware of the influence of this on the measured response.

10) Compare all measurements to see if there is good correspondence (i.e., system coverage is acceptable). If there is good correspondence, proceed to perform system equalization based on the average of all measurement locations. If your analyzer allows you to apply different weighting, give more weight to the console measurement (double it in the averaging). Use the parametric filters on the crossover inputs for performing system equalization. Another useful eq approach: invert the averaged measurement curve then use this as a target while electrically sweeping the equalizer and matching the eq curve to the target.

11) Verify the effects of equalization by repeating steps 8-10.

12) Adjust the subwoofer level according to subjective taste

13) Finalize EQ adjustments focussing on the 125-300 Hz region.

14) Predelay the entire system to the desired time reference. For example, if the drum monitor is the loudest element on stage use a system with time delay measurement capability to measure the time delay of the drum monitor with respect to the main system. Otherwise base your system predelay on the geometrically determined delay.

15) Repeat the eq procedure for fill arrays (L-L, R-R, downfill, frontfill, centre cluster)

16) Time align fill arrays to the main L, R arrays by locating a measurement mic in the transition region where the coverage patterns overlap.

17) Listen to a variety of familiar, well recorded program material

18) Attenuate fill arrays relative to the main L, R system as required

19) Compare program as reproduced by the system versus a pair of high quality reference headphones monitoring the output of the mixing console.. Voice the system with a good quality vocal microphone.

21) Verify tuning throughout the audience by walking the room and perform final adjustments using the analyzer between your ears!

c) SIM, MLSSA, TDS, SMAART, SpectraFOO Measurements

Equalization adjustments *can* be performed using an RTA analyzer with excellent results, however, more sophisticated measurement tools such as TDS, MLSSA, SIM, SMAART, SpectraFOO (for Macintosh) allow the user to obtain better results (provided these instruments are properly used, of course). Procedures using these measurement systems are identical to the techniques outlined above except for the fact that higher frequency and time domain resolution can be obtained along with time windowing capability to eliminate room reflections. In addition, impulse response domain measurements and the energy-time curve (ETC) are excellent tools for time alignment of subwoofers and delay systems, both in terms of accuracy and the actual time required for performing measurements and adjustments.

Signal averaging is generally very flexible and the ability to perform measurement weighting is possible with these measurement systems. For fixed installations where system equalization is remotely located, it is often useful to perform room measurements throughout a given array's coverage region then use a weighted spatial average to determine a house response curve. The house curve is then inverted and used as an equalization target for adjusting the system equalizer which can be swept electronically using the analyzer and adjusted to meet the target curve. Note: if a fullrange crossover ouput is available, this can be used to monitor the effects of input parametric filters (very useful with Smaart - use output 5 on the V-DOSC X LO/HI and 4W LO/HI presets).

In general, more sophisticated measurement equipment is necessary for setting up complex sound systems involving multiple sources, especially for doing electronic delay arc processing of subwoofer arrays. Additional information that is available related to room acoustics can also be useful for the tuning process – for example, RT_{60} at various frequencies and waterfall plots can help isolate resonance frequencies for a given room.

5.4 V-DOSC OPERATING MODES

V-DOSC system operating modes can be summarized as follows:

(1) Stereo 3-way

(2) Stereo 3-way plus single or dual mono 2-way fill (center cluster and/or front fill)

(3) Stereo 3-way plus stereo 2-way fill (stereo down- or front-fill)

(4) Stereo 3-way plus separate sub drive plus single or dual mono 2-way fill

(5) Stereo 3-way plus separate sub drive plus stereo 2-way fill

(6) Stereo 3-way plus 2-way Left-Left and Right-Right offstage fill

(7) Stereo 3-way plus 2-way Left-Left and Right-Right offstage fill plus dual mono 2-way fill

(8) Stereo 3-way plus 2-way Left-Left and Right-Right offstage fill plus stereo 2-way fill

(9) Stereo 3-way plus 3-way Left-Left and Right-Right offstage fill

(10) Stereo 3-way plus 3-way Left-Left and Right-Right offstage fill plus dual mono 2-way fill

(11) Stereo 3-way plus 3-way Left-Left and Right-Right offstage fill plus stereo 2-way fill

(12) Stereo 4-way

(13) Stereo 4-way plus single or dual mono 2-way fill (center cluster and/or front fill)

(14) Stereo 4-way plus stereo 2-way fill (stereo down- or front-fill)

(15) Stereo 4-way plus separate sub drive plus single or dual mono 2-way fill

(16) Stereo 4-way plus separate sub drive plus stereo 2-way fill

(17) Stereo 4-way plus 2-way Left-Left and Right-Right offstage fill

(18) Stereo 4-way plus 2-way Left-Left and Right-Right offstage fill plus dual mono 2-way fill

(19) Stereo 4-way plus 2-way Left-Left and Right-Right offstage fill plus stereo 2-way fill

(20) Stereo 4-way plus 3-way Left-Left and Right-Right offstage fill

(21) Stereo 4-way plus 3-way Left-Left and Right-Right offstage fill plus dual mono 2-way fill

(22) Stereo 4-way plus 3-way Left-Left and Right-Right offstage fill plus stereo 2-way fill

(23) Quad 4-way with quad 2-way down fill

(24) Quad 4-way with quad 2-way down fill plus separate sub drive with electronic arc capability

(25) Quad 4-way with quad 2-way down fill plus separate sub drive with electronic arc capability plus mono 2-way front fill and/or2-way center fill

As you can see, the V-DOSC system provides a very flexible, scaleable approach to sound design. For a general overview of these operating modes please refer to Figures 37 and 38. For details regarding specific array configurations and their suitability for given applications, please refer to Chapter 3 – Elements of Sound Design. Specific details regarding MULTI line assignments for these operating modes are discussed in Sections 5.5.

NOTE: L-ACOUSTICS does not support all operating modes as standard. Custom presets for specific operating modes and different fill enclosure combinations are available from L-ACOUSTICS by special order.

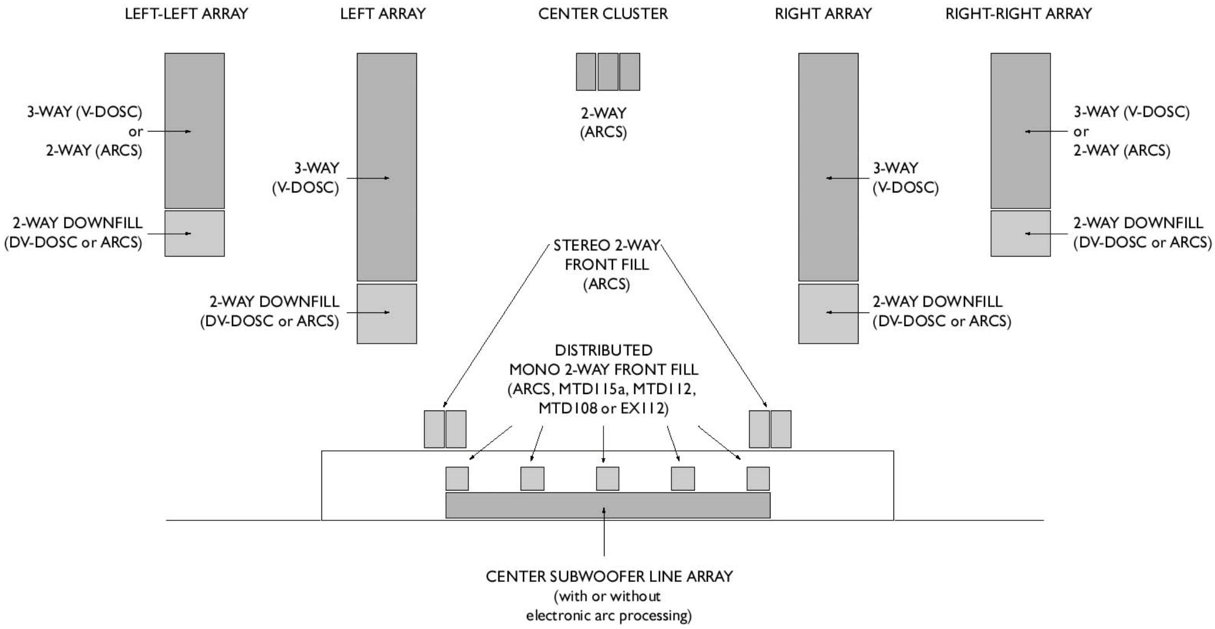


Figure 37: Array Elements of 3-Way System Design

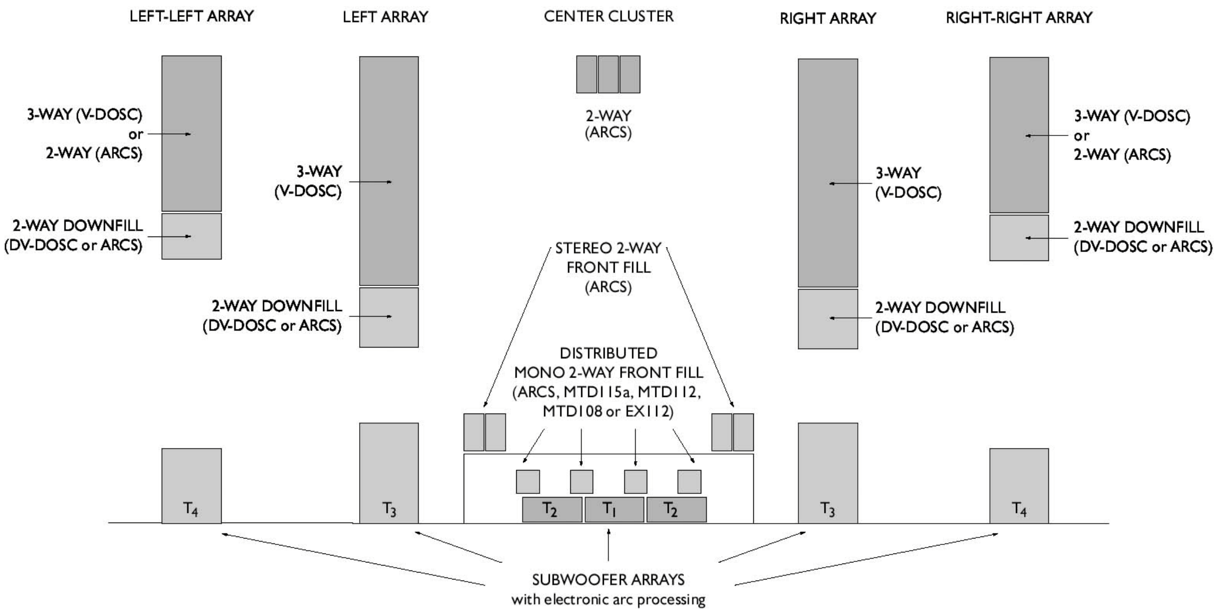


Figure 38: Array Elements of 4-Way System Design

6. MAINTENANCE AND INSTALLATION TOOLS

6.1 RECOMMENDED MAINTENANCE PROCEDURES

Regular maintenance procedures (monthly) include:

- component sweep (using sine wave generator or other suitable test system) and polarity check to ensure that all speakers and drivers are in good working order
- tighten all ANGLE strap shackles and inspect all double stud fittings
- cable continuity test (MULTI, AMP LINK, CROSS LINK, LINK-BREAKOUT, LINK SPLIT, LINK EXTEND, V-CABLE, V-LINK, F-CABLE, F-LINK, SUB cables)
- clean power amplifier filters
- verify crossover presets are correct and up to date

Periodic maintenance procedures (every 6-12 months) include:

- tighten dolley locator pins and all external fasteners on V-DOSC and SB218 enclosures
- tighten high frequency diaphragm mounting fasteners
- inspect all rigging components for wear and replace as necessary (i.e., rotating legs, rotating leg pins, U pins, rotating leg covers, flytrack sections, angle strap fittings)
- inspect wiring harnesses, internal connections for all panels

Occasional (as necessary) maintenance procedures include:

- refoam grilles
- repaint cabinets
- replace stacking runners
- replace protective covers for rotating legs

6.2 RECOMMENDED MAINTENANCE TOOLS

APPLICATION	V-DOSC SERVICE TOOLS	V-DOSC SERVICE TOOLS (USA only)
As Required	#2 Phillips screwdriver	#2 Phillips screwdriver
LF Speaker Mount	5 mm hex key	3/16 allen head socket driver (hex key)
LF Speaker Terminals	#13 wrench	#13 wrench
MF Speaker Mount	4 mm hex key	6/32 allen head socket driver (hex key)
HF Diaphragm Mount	4 mm hex key	4 mm allen head socket driver (hex key)
DOSC Waveguide Mount Bolt	10 mm socket	5/16 in SAE socket on 4 inch extension
Fly Track and Rotating Leg Cover	4 mm hex key	6/32 allen head socket driver (hex key)
Fly Track Mount Nut	10 mm socket	7/16 in wrench
Rotating Leg Housing Mount Bolt	5 mm	3/16 allen head socket driver (hex key)
Rotating Leg Mount Bolt	12 mm hex key	12 mm allen head socket driver (hex key)
Rotating Leg Mount Nut	22 mm wrench	½ in wrench
Dolley Locator Pin Mount	6 mm hex key	6 mm allen head socket driver (hex key)
Castor Mount Bolt	13 mm socket	½ in SAE Socket on 2 in extension

Miscellaneous Tools : adjustable pliers, rubber mallet, sidecutters, wire stripper, soldering iron, digital voltmeter (DVM), breakout cables for speaker testing (CA COM to banana leads)

6.3 SPARE PARTS

Speakers

HF driver (complete)	HP BC21
HF diaphragm	HS BC21
7" midrange speaker (complete)	HP FO71
15" speaker (complete)	HP PH151
15" speaker (recone kit)	HS PH151
18" speaker (220 mm magnet complete)	HP BE181
18" speaker (220 mm magnet recone kit)	HS BE182
18" speaker (260 mm magnet recone kit - old style)	HS BE181

Connectors

Female Panel Mount Speaker Connector (8 conductor)	CC 8B EF
Male Panel Mount Speaker Connector (8 conductor)	CC 8B EM
Female Speaker Connector – Line (8 conductor)	CC 8B FF
Male Speaker Connector – Line (8 conductor)	CC 8B FM
Male Extension Cable Connector – Line (8 conductor)	CC 8B FPM
Female Extension Cable Connector – Line (8 conductor)	CC 8B FPF
Male Panel Mount Link Connector (19 conductor)	CC 19B EM
Female Link Connector – Line (19 conductor)	CC 19B FF
Speakon Connector – Line (4 conductor)	CC 4 F
Speakon Connector – Panel Mount (4 conductor)	CC 4 ER
COMB Connector (25 pin)	CC 25SUBDM
COMB Connector (37 pin)	CC 37SUBDM

Accessories

Locking Pin (4.5 mm diameter: for U Pins)	CA GOUP45
Lanyard for CA GOUP45	CA_EL45
Locking Pin (6 mm diameter: for dolley board)	CA GOUP6
Lanyard for CA GOUP6	CA_EL6
Cabinet handle	CA POIG
Dolley board caster	CA ROL
Magnet for rotating leg	CD AIMAN
U-Pin	MC DOAXF-2
Left Balancier Cover (plastic)	MP_DORAIL_G
Right Balancier Cover (plastic)	MP_DORAIL_D
Bumper shackle	CA MAN22
ANGLE strap shackle	CA MAN81
ANGLE strap fitting	CA PION3
SB218 Grille Foam	CM SUB218 99
SB218 Front Grille	MC GRSUB218
V-DOSC Grille Foam	CM DOSC 99
V-DOSC Front Grille	MC GRDOSC
Neoprene glue for grille foam attachment	CD COLNEO
Brown paint (packaged by 10 kg)	CD TEXTURE
Dust filter clips for LA 48	APCLIP
Dust filters for LA 48	APFILT
Rear support kit for LA 48 amplifier	APSUP

6.4 RECOMMENDED INSTALLATION TOOLS

- Digital Inclinometer – Digital Protractor PRO 3600 (or equivalent)
- Remote Digital Inclinometer - LUCAS ANGLESTAR
- Laser Level Device - Laserline XPRO (or equivalent)
- Laser Rangefinder Binoculars - Bushnell Yardage Pro 600 (or equivalent)
- 2x 20 m (50 ft) tape measures
- Polarity Checker - PC 80 MK 11 SCV Audio, BSS (or equivalent)
- Portable computer with Excel (for ARRAY 2000), BSS Soundbench, XTA Audiocore and MLSSA or TEF or SMAART LIVE. Mac users - try Spectrafoo…

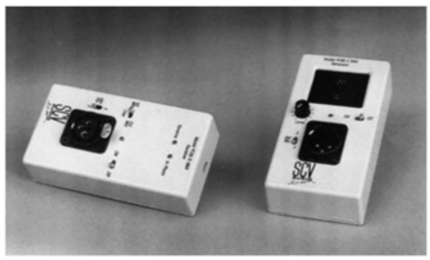
OPTIONAL INSTALLATION TOOLS

- Analog Inclimoter - SUUNTO PM-5/360PC
- Laser rangefinder measurement system - Leica Disto Classic, BFT2 rifle site, GLI22 level, tripod

Laser range-finder

Inclinometer

Real Time Analyzer



Polarity checker

Figure 39: Recommended Installation Tools

7. SPECIFICATIONS

7.1 V-DOSC ELEMENT SPECIFICATIONS

The specifications for one individual V-DOSC element are given below. These individual element specifications are not relevant to V-DOSC system performance since overall system behavior is the net result of the complex acoustical coupling between all elements of the array.

Frequency response (+/-3 dB)	50 Hz - 18 kHz
Full system bandwidth with SB218	25 Hz - 18 kHz

Power rating (pink noise)			**Impedance**
LF	2 x 375 W	(RMS)	8 ohms
MF	600 W	(RMS)	8 ohms
HF	200 W	(RMS)	16 ohms

Horizontal Coverage Angle	90° (-6 dB points, symmetrical about main axis) 70° (-3 dB points, symmetrical about main axis)
Vertical Coverage Angle	not defined for one element

System Data	*Continuous SPL (flat array)*	*Continuous SPL (maximum curvature)*
1 enclosure	134 dB	134 dB
2 enclosures	140 dB	139 dB (5 degrees vertical coverage)
4 enclosures	146 dB	143 dB (15 degrees vertical coverage)

LF	2 x 15" weather-resistant loudspeaker (3" voice coil, bass-reflex)
MF	4 x 7" weather-resistant loudspeaker (kevlar cone, bass-reflex)
HF	2 x 1.4" compression driver mounted on patented DOSC waveguide
Material	Baltic birch plywood. Sealed, screwed and rabbeted angles, internally braced cabinet construction
Finish	Maroon-gray
Grill	Black epoxy coated perforated steel with acoustically transparent foam
Features	Integrated flying hardware and handles
Dimension (WxHxD):	1300 mm x 434 mm x 565 mm (51.2" x 17.1" x 22.2")
Weight:	108 kg (238 lbs) + 9,5 kg (21 lbs) for dolley

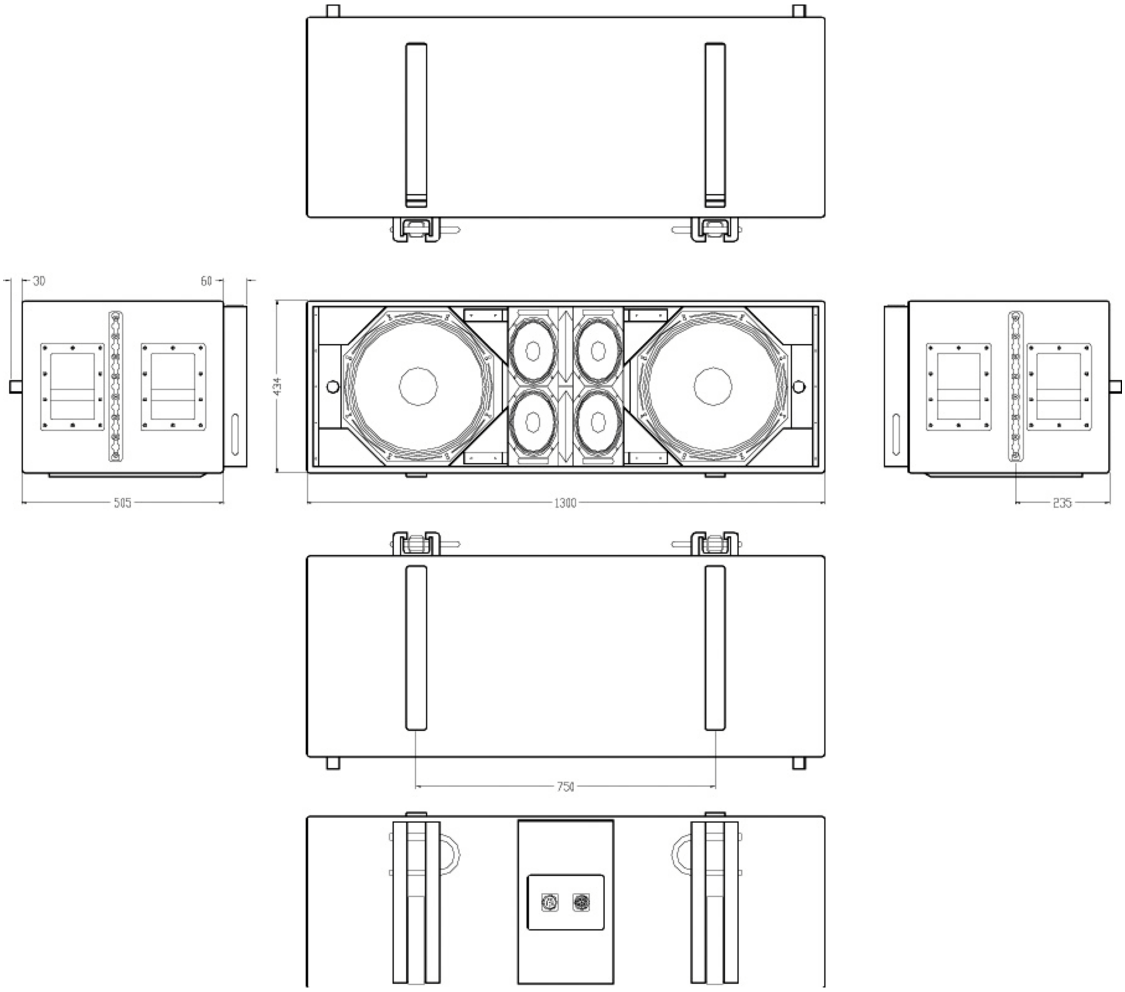


Figure 40: V-DOSC Element – Line Drawing

Scale 1 :20

7.2 SB218 SUBWOOFER SPECIFICATIONS

Frequency Response	28 Hz - 140 Hz (+/- 3 dB)
Usable Bandwidth	25 Hz - 200 Hz
Sensitivity (2.83 V at 1m)	100.5 dB SPL (25-200 Hz, freefield conditions)
Power rating	68 Vrms 1100 Wrms 4400 Wpeak (long term pink noise with 6 dB crest factor)
Impedance	4 ohms
Components	2 x 18" cone bass-reflex, 4.5" edgewound copper voice coil
Material	Baltic birch plywood. Sealed, screwed cabinet construction
Finish	Maroon-gray
Grill	Black epoxy perforated steel with acoustically transparent foam
Features	Integrated flying hardware, handles
Dimension (WxHxD):	1300 mm x 550 mm x 700 mm (51.2" x 21.7" x 27.6")
Weight:	106 kg (233 lbs) + 9,5 kg (21 lbs) for dolley

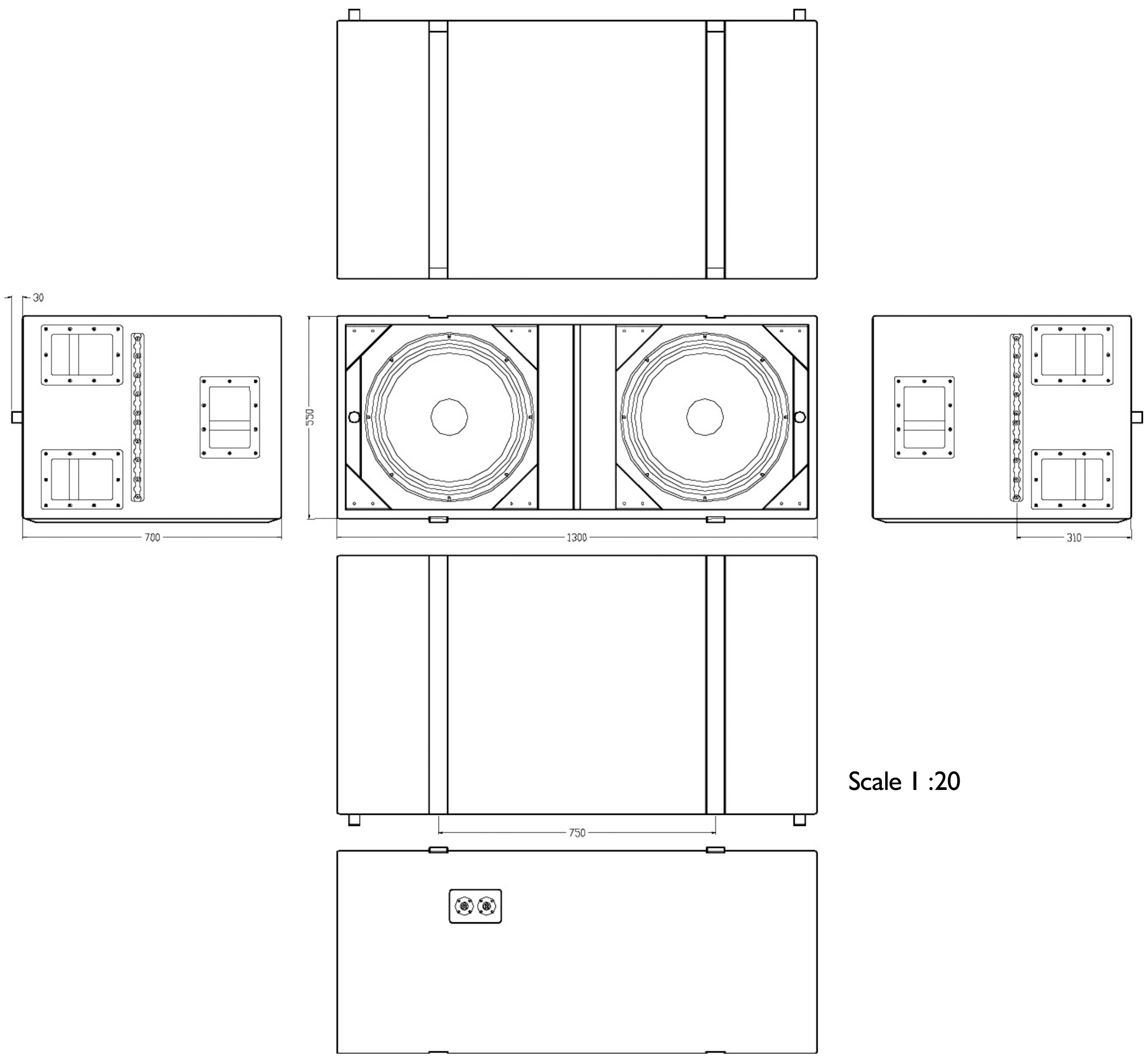


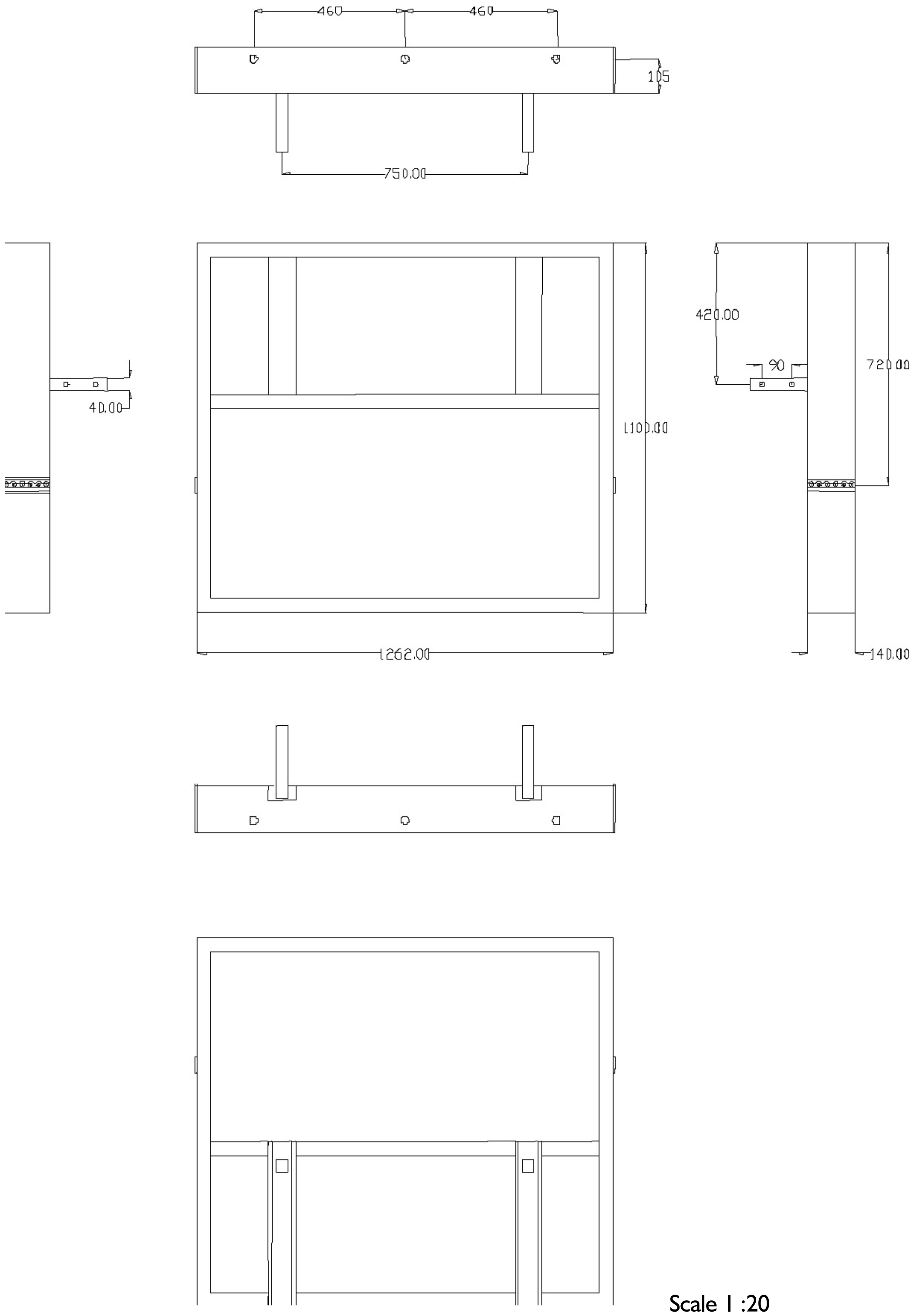
Figure 41: SB218 Subwoofer – Line Drawing

7.3 FLYING STRUCTURES

a) V-DOSC Flying Bumper

Dimension (WxHxD): 1262 mm x 140 mm x 1100 mm
(49-5/8" x 5-4/8" x 43-3/8")

Weight: 61.5 kg (135.6 lbs)



Scale 1 :20

Figure 42: V-DOSC Flying Bumper – Line Drawing

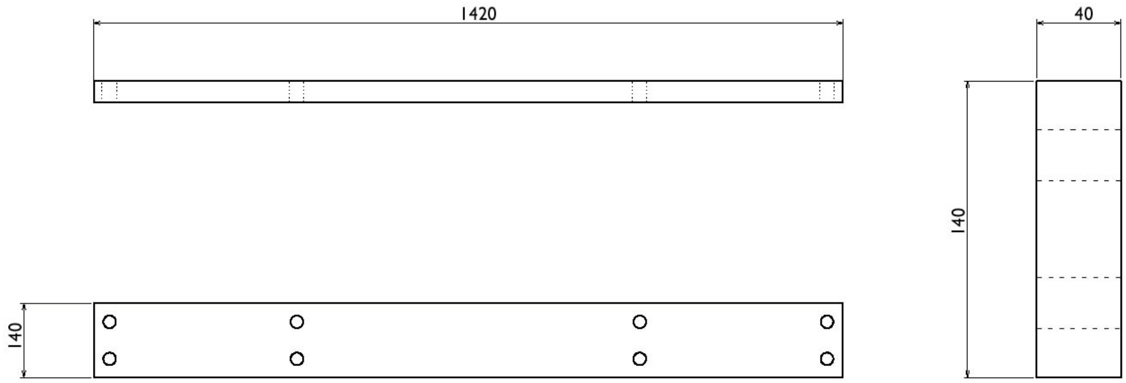
Table 12: Weights for flown V-DOSC system

Number of V-DOSC Cabinets	Cabinet Weight (kg)	Bumper Weight (kg)	TOTAL Weight (kg)	TOTAL Weight (lbs)
4	432	61	493	1087
5	540	61	601	1325
6	648	61	709	1563
7	756	61	817	1801
8	864	61	925	2039
9	972	61	1033	2277
10	1080	61	1141	2515
11	1188	61	1249	2754
12	1296	61	1357	2992
13	1404	61	1465	3230
14	1512	61	1573	3468
15	1620	61	1681	3706
16	1728	61	1789	3944

b) SB218 Flying Bar

Dimension (WxHxD): 1420 mm x 140 mm x 40 mm
(55-7/8" x 5-4/8" x 1-5/8")

Weight: 12 kg (26.5 lbs)



Scale 1:20/1:5

Figure 43: SB218 Flying Bar – Line Drawing

7.4 C024, MD24 LINE ASSIGNMENT SUMMARY

Table 13: Whirlwind W6 MASS Connector Input/Output Line Assignments

<table>
<tr><th colspan="3">W6 OUTPUT (CO24)</th></tr>
<tr><th>WHIRLWIND PAIR NUMBER</th><th>W6 PINS XLR ||CACOM ASSIGNMENT</th><th>W6 SOCKETS XLR ||CACOM ASSIGNMENT</th></tr>
<tr><td>1</td><td>A4 || A (ABC)</td><td></td></tr>
<tr><td>2</td><td></td><td>C4 || C (ABC)</td></tr>
<tr><td>3</td><td>A3 || A (DEF)</td><td></td></tr>
<tr><td>4</td><td></td><td>C3 || C (DEF)</td></tr>
<tr><td>5</td><td>A2 || A (GHJ)</td><td></td></tr>
<tr><td>6</td><td></td><td>C2 || C (GHJ)</td></tr>
<tr><td>7</td><td>A1 || A (KLM)</td><td></td></tr>
<tr><td>8</td><td></td><td>C1 || C (KLM)</td></tr>
<tr><td>9</td><td>A6 || A (NPR)</td><td></td></tr>
<tr><td>10</td><td></td><td>C6 || C (NPR)</td></tr>
<tr><td>11</td><td>A5 || A (STU)</td><td></td></tr>
<tr><td>12</td><td></td><td>C5 || C (STU)</td></tr>
<tr><td>13</td><td>B4 || B (ABC)</td><td></td></tr>
<tr><td>14</td><td></td><td>D4 || D (ABC)</td></tr>
<tr><td>15</td><td>B3 || B (DEF)</td><td></td></tr>
<tr><td>16</td><td></td><td>D3 || D (DEF)</td></tr>
<tr><td>17</td><td>B2 || B (GHJ)</td><td></td></tr>
<tr><td>18</td><td></td><td>D2 || D (GHJ)</td></tr>
<tr><td>19</td><td>B1 || B (KLM)</td><td></td></tr>
<tr><td>20</td><td></td><td>D1 || D (KLM)</td></tr>
<tr><td>21</td><td>B6 || B (NPR)</td><td></td></tr>
<tr><td>22</td><td></td><td>D6 || D (NPR)</td></tr>
<tr><td>23</td><td>B5 || B (STU)</td><td></td></tr>
<tr><td>24</td><td></td><td>D5 || D (STU)</td></tr>
<tr><td>25</td><td>REMOTE OUT (M)</td><td></td></tr>
<tr><td>26</td><td></td><td>REMOTE IN (F)</td></tr>
<tr><td>27</td><td>REMOTE OUT (M)</td><td></td></tr>
<tr><td>28</td><td></td><td>REMOTE IN (F)</td></tr>
</table>

NOTE:

REMOTE OUT = 4 pin MALE XLR on front panel
(return signal from amplifiers to computer)

REMOTE IN = 4 pin FEMALE XLR on front panel
(control signal from computer to amplifiers)

<table>
<tr><th colspan="3">W6 INPUT (MD24)</th></tr>
<tr><th>WHIRLWIND PAIR NUMBER</th><th>W6 PINS CACOM ASSIGNMENT</th><th>W6 SOCKETS CACOM ASSIGNMENT</th></tr>
<tr><td>1</td><td></td><td>A (ABC)</td></tr>
<tr><td>2</td><td>C (ABC)</td><td></td></tr>
<tr><td>3</td><td></td><td>A (DEF)</td></tr>
<tr><td>4</td><td>C (DEF)</td><td></td></tr>
<tr><td>5</td><td></td><td>A (GHJ)</td></tr>
<tr><td>6</td><td>C (GHJ)</td><td></td></tr>
<tr><td>7</td><td></td><td>A (KLM)</td></tr>
<tr><td>8</td><td>C (KLM)</td><td></td></tr>
<tr><td>9</td><td></td><td>A (NPR)</td></tr>
<tr><td>10</td><td>C (NPR)</td><td></td></tr>
<tr><td>11</td><td></td><td>A (STU)</td></tr>
<tr><td>12</td><td>C (STU)</td><td></td></tr>
<tr><td>13</td><td></td><td>B (ABC)</td></tr>
<tr><td>14</td><td>D (ABC)</td><td></td></tr>
<tr><td>15</td><td></td><td>B (DEF)</td></tr>
<tr><td>16</td><td>D (DEF)</td><td></td></tr>
<tr><td>17</td><td></td><td>B (GHJ)</td></tr>
<tr><td>18</td><td>D (GHJ)</td><td></td></tr>
<tr><td>19</td><td></td><td>B (KLM)</td></tr>
<tr><td>20</td><td>D (KLM)</td><td></td></tr>
<tr><td>21</td><td></td><td>B (NPR)</td></tr>
<tr><td>22</td><td>D (NPR)</td><td></td></tr>
<tr><td>23</td><td></td><td>B (STU)</td></tr>
<tr><td>24</td><td>D (STU)</td><td></td></tr>
<tr><td>25</td><td></td><td>REMOTE IN (F)</td></tr>
<tr><td>26</td><td>REMOTE OUT (M)</td><td></td></tr>
<tr><td>27</td><td></td><td>REMOTE IN (F)</td></tr>
<tr><td>28</td><td>REMOTE OUT (M)</td><td></td></tr>
</table>

NOTE:

REMOTE OUT = 4 pin MALE XLR on front panel
(control signal from computer to amplifiers)

REMOTE IN = 4 pin FEMALE XLR on front panel
(return signal from amplifiers to computer)

7.5 CO24 CONTROL OUTPUT PANEL LINE ASSIGNMENTS

Table 14a: CO24 W6 Pin Assignments

W6 PIN #	W6 COLOR CODE	XLR #	XLR PIN	CACOM CHANNEL	CACOM PIN	PROCESSOR CHANNEL	LOUDSPEAKER ARRAY
42	BLACK	A4	3	A	C	HF	LEFT-LEFT
41	RED	A4	2	A	B	HF	LEFT-LEFT
40	GND	A4	1	A	A	HF	LEFT-LEFT
39	BLACK	A3	3	A	F	MID	LEFT-LEFT
38	GREEN	A3	2	A	E	MID	LEFT-LEFT
37	GND	A3	1	A	D	MID	LEFT-LEFT
36	BLACK	A2	3	A	J	LF	LEFT-LEFT
35	YELLOW	A2	2	A	H	LF	LEFT-LEFT
34	GND	A2	1	A	G	LF	LEFT-LEFT
33	BLACK	A1	3	A	M	SUB	LEFT-LEFT
32	ORANGE	A1	2	A	L	SUB	LEFT-LEFT
22	GND	A1	1	A	K	SUB	LEFT-LEFT
31	RED	A6	3	A	R	2-WAY FILL HF	LEFT-LEFT
30	GREEN	A6	2	A	P	2-WAY FILL HF	LEFT-LEFT
29	GND	A6	1	A	N	2-WAY FILL HF	LEFT-LEFT
28	RED	A5	3	A	U	2-WAY FILL LF	LEFT-LEFT
27	YELLOW	A5	2	A	T	2-WAY FILL LF	LEFT-LEFT
26	GND	A5	1	A	S	2-WAY FILL LF	LEFT-LEFT
25	RED	B4	3	B	C	HF	LEFT
24	ORANGE	B4	2	B	B	HF	LEFT
23	GND	B4	1	B	A	HF	LEFT
21	GREEN	B3	3	B	F	MID	LEFT
20	BLUE	B3	2	B	E	MID	LEFT
19	GND	B3	1	B	D	MID	LEFT
18	GREEN	B2	3	B	J	LF	LEFT
17	BROWN	B2	2	B	H	LF	LEFT
16	GND	B2	1	B	G	LF	LEFT
15	WHITE	B1	3	B	M	SUB	LEFT
14	BLUE	B1	2	B	L	SUB	LEFT
13	GND	B1	1	B	K	SUB	LEFT
12	WHITE	B6	3	B	R	2-WAY FILL HF	LEFT
11	BROWN	B6	2	B	P	2-WAY FILL HF	LEFT
4	GND	B6	1	B	N	2-WAY FILL HF	LEFT
10	BLUE	B5	3	B	U	2-WAY FILL LF	LEFT
9	YELLOW	B5	2	B	T	2-WAY FILL LF	LEFT
8	GND	B5	1	B	S	2-WAY FILL LF	LEFT
7	BLUE	REMOTE OUT	M 4pin XLR #1				
6	ORANGE	REMOTE OUT	M 4pin XLR #2				
5	GND						
3	BROWN	REMOTE OUT	M 4pin XLR #3				
2	ORANGE	REMOTE OUT	M 4pin XLR #4				
1	GND						

Table 14b: CO24 W6 Socket Assignments

W6 Socket #	W6 COLOR CODE	XLR #	XLR PIN	CACOM CHANNEL	CACOM PIN	PROCESSOR CHANNEL	LOUDSPEAKER ARRAY
42	BLACK	C4	3	C	C	HF	RIGHT
41	WHITE	C4	2	C	B	HF	RIGHT
40	GND	C4	1	C	A	HF	RIGHT
39	BLACK	C3	3	C	F	MID	RIGHT
38	BLUE	C3	2	C	E	MID	RIGHT
37	GND	C3	1	C	D	MID	RIGHT
36	BLACK	C2	3	C	J	LF	RIGHT
35	BROWN	C2	2	C	H	LF	RIGHT
34	GND	C2	1	C	G	LF	RIGHT
33	RED	C1	3	C	M	SUB	RIGHT
32	WHITE	C1	2	C	L	SUB	RIGHT
22	GND	C1	1	C	K	SUB	RIGHT
31	RED	C6	3	C	R	2-WAY FILL HF	RIGHT
30	BLUE	C6	2	C	P	2-WAY FILL HF	RIGHT
29	GND	C6	1	C	N	2-WAY FILL HF	RIGHT
28	RED	C5	3	C	U	2-WAY FILL LF	RIGHT
27	BROWN	C5	2	C	T	2-WAY FILL LF	RIGHT
26	GND	C5	1	C	S	2-WAY FILL LF	RIGHT
25	GREEN	D4	3	D	C	HF	RIGHT-RIGHT
24	WHITE	D4	2	D	B	HF	RIGHT-RIGHT
23	GND	D4	1	D	A	HF	RIGHT-RIGHT
21	GREEN	D3	3	D	F	MID	RIGHT-RIGHT
20	YELLOW	D3	2	D	E	MID	RIGHT-RIGHT
19	GND	D3	1	D	D	MID	RIGHT-RIGHT
18	GREEN	D2	3	D	J	LF	RIGHT-RIGHT
17	ORANGE	D2	2	D	H	LF	RIGHT-RIGHT
16	GND	D2	1	D	G	LF	RIGHT-RIGHT
15	WHITE	D1	3	D	M	SUB	RIGHT-RIGHT
14	YELLOW	D1	2	D	L	SUB	RIGHT-RIGHT
13	GND	D1	1	D	K	SUB	RIGHT-RIGHT
12	WHITE	D6	3	D	R	2-WAY FILL HF	RIGHT-RIGHT
11	ORANGE	D6	2	D	P	2-WAY FILL HF	RIGHT-RIGHT
4	GND	D6	1	D	N	2-WAY FILL HF	RIGHT-RIGHT
10	BLUE	D5	3	D	U	2-WAY FILL LF	RIGHT-RIGHT
9	BROWN	D5	2	D	T	2-WAY FILL LF	RIGHT-RIGHT
8	GND	D5	1	D	S	2-WAY FILL LF	RIGHT-RIGHT
7	BROWN	REMOTE IN	F 4pin XLR #1				
6	YELLOW	REMOTE IN	F 4pin XLR #2				
5	GND						
3	ORANGE	REMOTE IN	F 4pin XLR #3				
2	YELLOW	REMOTE IN	F 4pin XLR #4				
1	GND						

7.6 MD24 MULTIDISTRO PANEL LINE ASSIGNMENTS

Table 15a: MD24 W6 Pin Assignments

W6 PIN #	W6 COLOR CODE	CACOM CHANNEL	CACOM PIN	PROCESSOR CHANNEL	LOUDSPEAKER ARRAY
42	BLACK	C	C	HF	RIGHT
41	WHITE	C	B	HF	RIGHT
40	GND	C	A	HF	RIGHT
39	BLACK	C	F	MID	RIGHT
38	BLUE	C	E	MID	RIGHT
37	GND	C	D	MID	RIGHT
36	BLACK	C	J	LF	RIGHT
35	BROWN	C	H	LF	RIGHT
34	GND	C	G	LF	RIGHT
33	RED	C	M	SUB	RIGHT
32	WHITE	C	L	SUB	RIGHT
22	GND	C	K	SUB	RIGHT
31	RED	C	R	2-WAY FILL HF	RIGHT
30	BLUE	C	P	2-WAY FILL HF	RIGHT
29	GND	C	N	2-WAY FILL HF	RIGHT
28	RED	C	U	2-WAY FILL LF	RIGHT
27	BROWN	C	T	2-WAY FILL LF	RIGHT
26	GND	C	S	2-WAY FILL LF	RIGHT
25	GREEN	D	C	HF	RIGHT-RIGHT
24	WHITE	D	B	HF	RIGHT-RIGHT
23	GND	D	A	HF	RIGHT-RIGHT
21	GREEN	D	F	MID	RIGHT-RIGHT
20	YELLOW	D	E	MID	RIGHT-RIGHT
19	GND	D	D	MID	RIGHT-RIGHT
18	GREEN	D	J	LF	RIGHT-RIGHT
17	ORANGE	D	H	LF	RIGHT-RIGHT
16	GND	D	G	LF	RIGHT-RIGHT
15	WHITE	D	M	SUB	RIGHT-RIGHT
14	YELLOW	D	L	SUB	RIGHT-RIGHT
13	GND	D	K	SUB	RIGHT-RIGHT
12	WHITE	D	R	2-WAY FILL HF	RIGHT-RIGHT
11	ORANGE	D	P	2-WAY FILL HF	RIGHT-RIGHT
4	GND	D	N	2-WAY FILL HF	RIGHT-RIGHT
10	BLUE	D	U	2-WAY FILL LF	RIGHT-RIGHT
9	BROWN	D	T	2-WAY FILL LF	RIGHT-RIGHT
8	GND	D	S	2-WAY FILL LF	RIGHT-RIGHT
7	BROWN	REMOTE OUT	M 4pin XLR #1		
6	YELLOW	REMOTE OUT	M 4pin XLR #2		
5	GND				
3	ORANGE	REMOTE OUT	M 4pin XLR #3		
2	YELLOW	REMOTE OUT	M 4pin XLR #4		
1	GND				

Table 15b: MD24 W6 Socket Assignments

W6 Socket #	W6 COLOR CODE	CACOM CHANNEL	CACOM PIN	PROCESSOR CHANNEL	LOUDSPEAKER ARRAY
42	BLACK	A	C	HF	LEFT-LEFT
41	RED	A	B	HF	LEFT-LEFT
40	GND	A	A	HF	LEFT-LEFT
39	BLACK	A	F	MID	LEFT-LEFT
38	GREEN	A	E	MID	LEFT-LEFT
37	GND	A	D	MID	LEFT-LEFT
36	BLACK	A	J	LF	LEFT-LEFT
35	YELLOW	A	H	LF	LEFT-LEFT
34	GND	A	G	LF	LEFT-LEFT
33	BLACK	A	M	SUB	LEFT-LEFT
32	ORANGE	A	L	SUB	LEFT-LEFT
22	GND	A	K	SUB	LEFT-LEFT
31	RED	A	R	2-WAY FILL HF	LEFT-LEFT
30	GREEN	A	P	2-WAY FILL HF	LEFT-LEFT
29	GND	A	N	2-WAY FILL HF	LEFT-LEFT
28	RED	A	U	2-WAY FILL LF	LEFT-LEFT
27	YELLOW	A	T	2-WAY FILL LF	LEFT-LEFT
26	GND	A	S	2-WAY FILL LF	LEFT-LEFT
25	RED	B	C	HF	LEFT
24	ORANGE	B	B	HF	LEFT
23	GND	B	A	HF	LEFT
21	GREEN	B	F	MID	LEFT
20	BLUE	B	E	MID	LEFT
19	GND	B	D	MID	LEFT
18	GREEN	B	J	LF	LEFT
17	BROWN	B	H	LF	LEFT
16	GND	B	G	LF	LEFT
15	WHITE	B	M	SUB	LEFT
14	BLUE	B	L	SUB	LEFT
13	GND	B	K	SUB	LEFT
12	WHITE	B	R	2-WAY FILL HF	LEFT
11	BROWN	B	P	2-WAY FILL HF	LEFT
4	GND	B	N	2-WAY FILL HF	LEFT
10	BLUE	B	U	2-WAY FILL LF	LEFT
9	YELLOW	B	T	2-WAY FILL LF	LEFT
8	GND	B	S	2-WAY FILL LF	LEFT
7	BLUE	REMOTE IN	F 4pin XLR #1		
6	ORANGE	REMOTE IN	F 4pin XLR #2		
5	GND				
3	BROWN	REMOTE IN	F 4pin XLR #3		
2	ORANGE	REMOTE IN	F 4pin XLR #4		
1	GND				

7.7 APPROVED AMPLIFIER SPECIFICATIONS

a) L-ACOUSTICS LA 48

The LA 48 is configured with the input sensitivity set for a constant gain of +32 dB. For this setting, the maximum power level is attained when the input is fed with a signal level of 2.30 Vrms which is equivalent to +7.2 dBV or +9.5 dBu. At higher levels, the limiters of the amplifiers begin to function and the "clip" LED indicators of the amplifiers light up. For a more detailed description of the LA 48 please refer to the L-ACOUSTICS LA 48 Users Manual.

A brief summary of important specifications follows:

INPUT SENSITIVITY	2.30 Vrms (+9.5 dBu)
GAIN	32 dB gain (specified setting for V-DOSC)
	1 kHz, 0.1% THD (nominal)
POWER	1300 W @ 8 ohms 2100 W @ 4 ohms 2400 W @ 2 ohms

b) CROWN MA-5000VZ

The CROWN MA-5000VZ amplifier is nominally set at 1.4 Vrms input sensitivity. This setting is equivalent to +2.9 dBV or +5.1dBu input sensitivity and provides a constant gain of 37 dB. However; in order to remain compatible with the 32 dB gain specified for the V-DOSC standard a PIP card is required.

Please refer to the CROWN MA-5000VZ manual for a complete description of LED readouts – different combinations of ODEP, Signal/IOC and I-Load/I-Limit indications have different meanings.

A brief summary of important specifications follows:

INPUT SENSITIVITY	1.4Vrms (+5.14 dBu)
GAIN	32 dB gain (specified setting for V-DOSC – requires PIP card)
	Maximum at 1 kHz, 0.1% THD
POWER	1300 W @ 8 ohms 1850 W @ 4 ohms 2400 W @ 2 ohms

c) Lab Gruppen 4000

For a detailed description of the 4000 please refer to the LAB GRUPPEN Users Manual. A brief summary of important specifications follows:

INPUT SENSITIVITY	2.30 Vrms (+9.5 dBu)
GAIN	32 dB gain (specified setting for V-DOSC – available on request)
	EIA: 1 kHz, 1% THD
POWER	1300 W @ 8 ohms 2100 W @ 4 ohms 2400 W @ 2 ohms

APPENDIX 1:
WHY DO SEPARATED SOUND SOURCES INTERFERE?

When two sources are physically separated, such as two speakers or two horns in an array, the slightly different arrival times of the wavefronts radiated by the individual sources cause frequency- and position-dependent constructive and destructive interference. This, in turn, leads to problems in terms of coverage, pattern control, intelligibility and frequency response consistency.

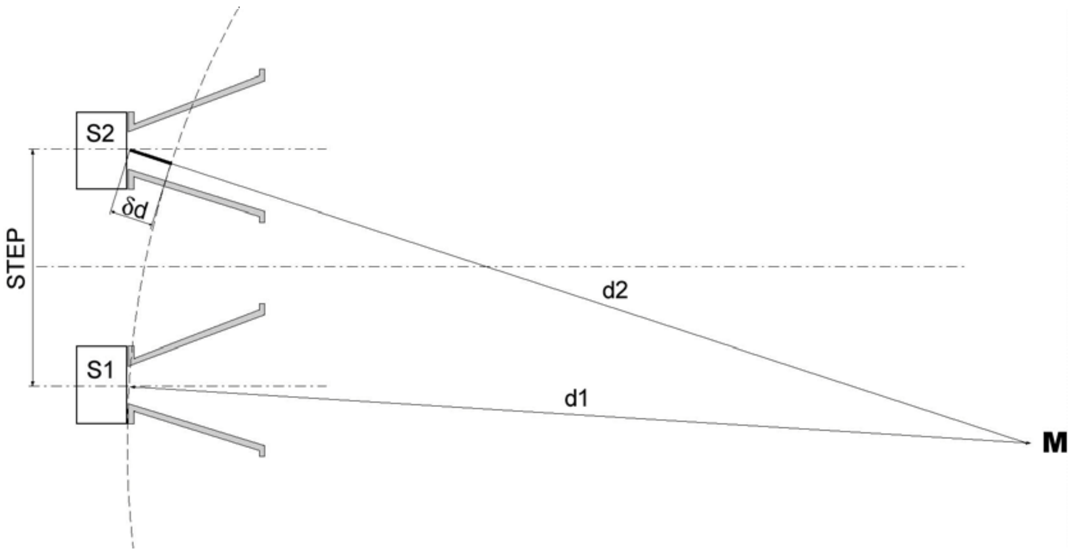


Figure 44: The Interference Problem

If P_1 is the sound pressure produced by S_1 at point M, and P_2 the pressure produced by S_2 at point M, the complex sound pressure P_m resulting from the addition of the two speakers at point M is formally calculated as:

$$P_m = P_1 e^{\left[2j\pi f\left(t-\frac{d1}{c}\right)\right]} + P_2 e^{\left[2j\pi f\left(t-\frac{d2}{c}\right)\right]}$$

If both sources radiate the same pressure P and the real part of the complex sound pressure at M is considered at time $t=t_1=d_1/c$, the expression simplifies to:

$$P_m = P\left[1+\cos\left(2\pi f\frac{\delta d}{c}\right)\right]$$

where the path length difference $d_2\text{-}d_1 = \delta d$.

From the simplified expression, it is seen that the second source causes a frequency dependent phase shift given by: $\delta\vartheta = 2\pi\ f\ \delta d/c$. When $\delta\vartheta=(2n + 1)\pi$, where n=0,1,2,3…integer, pressure cancellations occur, since $\cos(2n+1)\pi = -1$.

As a consequence, pressure cancellation occurs for all frequencies that satisfy the condition:

$2f\ \delta d/c = 2n + 1$ where n is an integer.

For example when δd = 0.33 m (i.e. δt = 1 msec), this yields cancellations at 500Hz, 1500Hz, 2500Hz, ... producing what audio engineers term comb filtering in the frequency response. The biggest problem with comb filtering is the fact that these cancellations are not consistent with frequency since the time differences change depending on the observer location M.

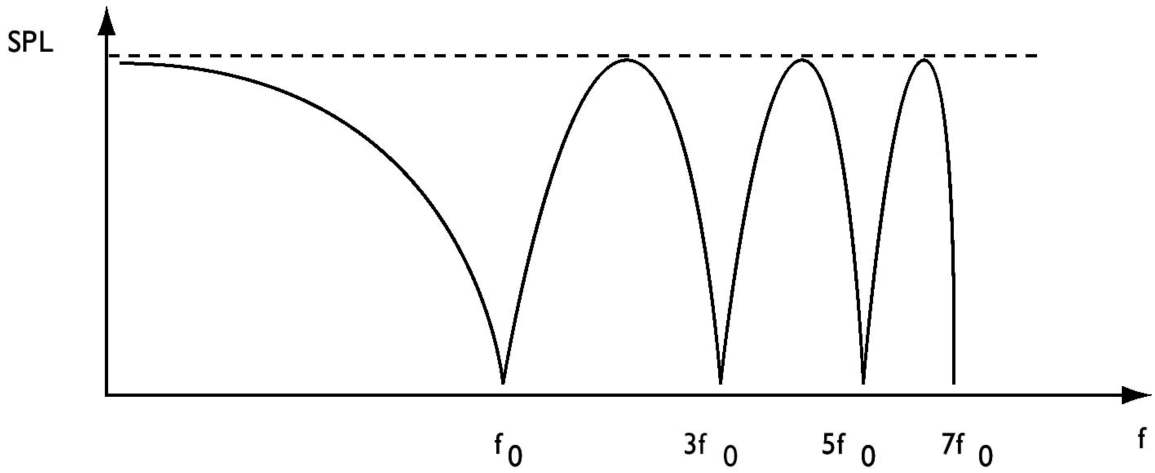


Figure 45: Comb filtering due to path length differences between sources

As discussed in Section 3.1a), the principles of 2 source interference can be used in sound design when considering multiple V-DOSC arrays since, in effect, the main and offstage V-DOSC arrays act as 2 coherent sound sources. When a separation of 6-8 metres is maintained between the 2 V-DOSC arrays, this shifts the first null seen in Figure 45 (fo) down to approximately 15-25 Hz and this cancellation is inaudible. The second and third nulls (3fo, 5fo) tend to be filled in or masked by room reverberation. Higher frequency cancellations (7fo and higher) are too tightly spaced for the ear to resolve, plus focussing the aiming axes of the two arrays at different angles helps to minimize the area over which comb filtering interaction takes place.

APPENDIX 2:
FURTHER EXPLANATIONS REGARDING WST CRITERIA

A detailed formulation of Wavefront Sculpture Technology Criteria was developed in "Sound Fields Radiated by Multiple Sound Source Arrays", AES preprint n°3269 (presented at the 92nd AES convention in Vienna, March 1992). Further theoretical research was developed in "Wavefront Sculpture Technology" (prepared for the 111th AES Convention, NYC, Sept 2001, preprint # not available at the time of this manual revision). The following explanation provides a more intuitive description of WST criteria (along the lines of the NYC Convention preprint), with the intention of describing where the ideas for the research that finally led to WST came from.

Returning to the interference problem introduced in Appendix 1, the time/frequency relationship can be expressed in a different way, i.e., in the distance/wavelength domain.

Since $\lambda = c / f$ (i.e., wavelength = speed of sound divided by the frequency) and $\delta d = c\ \delta t$ (i.e., path length difference = speed of sound times the arrival time difference), pressure cancellations occur when the path length difference between two wavefronts arriving at an observation point M is:

$$\delta d = (2n + 1)\ \lambda/2 \qquad \text{where n is an integer.}$$

We can therefore conclude that discrete sound sources produce a totally incoherent wavefront (due to comb filtering effects) as soon as the path length difference between the sources to a given point M is greater than $\lambda/2$ (half a wavelength).

Let's consider a line array of discrete sound sources providing almost equal pressure levels at M. We want to find the conditions for constructive coupling of the sound sources for a given frequency $f = c / \lambda$.

Assume that the time of the first arrival at M of this multiple source wavefront is $t_i = d_i / c$ where it is seen in Figure 46 that the first arrival is due to source i (physically the closest source to M).

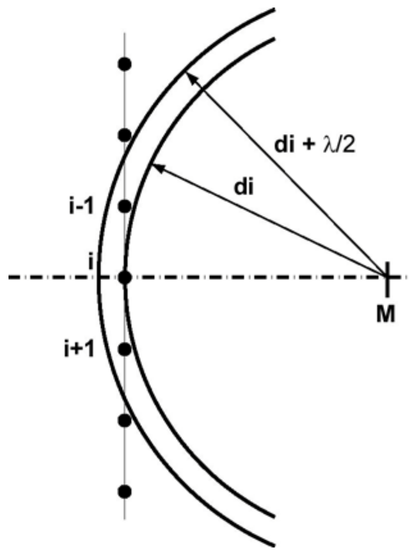


Figure 46: Destructive interference ring for a line array at observation point M.

If a circle of radius d_i is centered at M, it intersects source i. Recalling the condition that

$\delta d = (2n + 1)\ \lambda/2$, a second circle can be drawn with a radius of $d_i + \lambda/2$, i.e., n = 0 in the expression for the path length difference. If adjacent sources are inside the ring defined by $(d_i, d_i + \lambda/2)$ then they do not cause cancellation – they couple constructively. If sources are outside the ring they may cause cancellation.

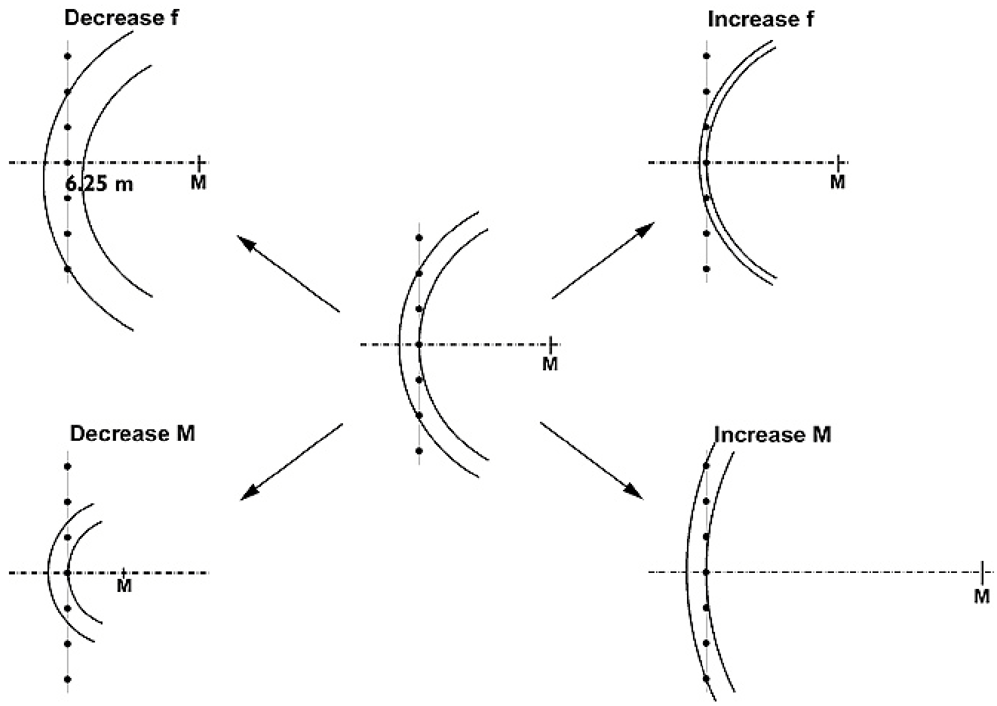


Figure 47: The effect of varying frequency and listener position M on Fresnel rings

As seen in Figure 47, when decreasing the frequency while maintaining the same listener position, wavelengths get larger and the ring spacing gets bigger so that more sources fall within the ring and couple constructively at M. Conversely, as the frequency increases, fewer sources fall within the ring and add constructively at M. Maintaining the same frequency (and therefore the same ring spacing) and moving the position M closer to the array means that the radius of curvature of the rings is decreased, therefore fewer sources fall within the ring. Moving the listener position further away, the radius of curvature increases and more sources fall within the constructive ring.

Now let's draw all circles with radii defined by: $\delta d = (2n + 1)\ \lambda/2$. The destructive areas where total cancellation occurs are shown in gray in Figure 48. White areas are constructive interference zones.

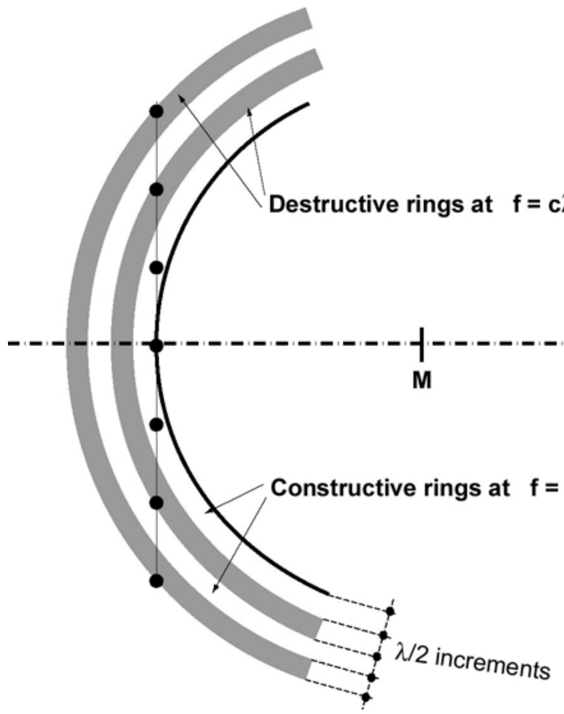


Figure 48: Destructive and constructive interference rings for a line array at observation point M.

We can now compare the number of sound sources inside the constructive rings to the number of sources inside the destructive rings. When these numbers are almost equal, sound sources are globally conflicting and produce an incoherent wavefield at M. When there are significantly more sound sources within the constructive rings, the same collection of sound sources produces a coherent wavefield at M.

It should be noted that this method is due to Fresnel – he used this type of analysis to describe light interference at the beginning of the century!

If we repeat this analysis for different M locations, we can draw a map that shows where the sound field is coherent or incoherent. When it appears that there is no constructive wavefield over a given area, we declare the wavefield to be chaotic. If we can define an area where the wavefront is highly constructive, the sound pressure level will be much higher than in a destructive area. We can thus define the effective coverage of the array for this given frequency.

The goal for the sound designer is to clearly identify an area where the wavefield is coherent - not just for a given frequency, but for the whole frequency range of the sound source.

How can we achieve this goal?

The logical first step is to minimize the distance between sound sources. By doing this for a given frequency, we have a better chance of maximizing the number of sources within the first constructive ring. This situation is more likely to be achieved on the main axis (perpendicular to the line array), as shown in Figure 49. Note that in Figure 49, the source separation is smaller than in Figure 48 so that more sources lie within the first constructive ring. Deviating from the main axis as in Figure 50, the number of sources within the first constructive ring decreases progessively, until there are equal numbers of constructive and destructive sources and the area then becomes totally incoherent. Clear separation between coherent and incoherent wave-fields defines the consistency of the main coverage region.

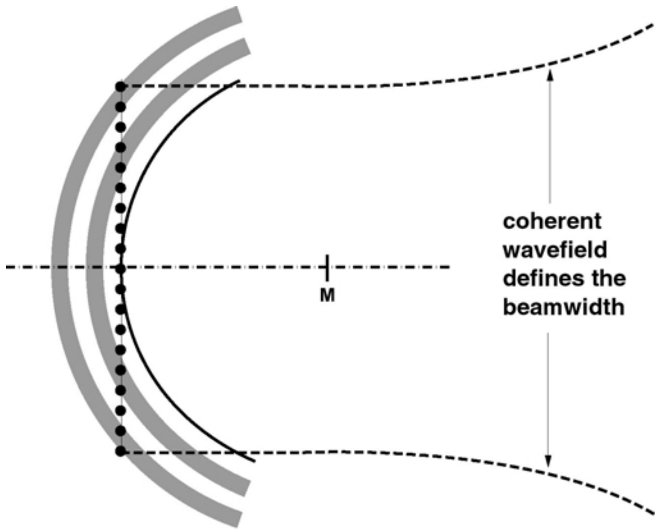


Figure 49: Constructive interference rings for a condensed point source line array at observation point M.

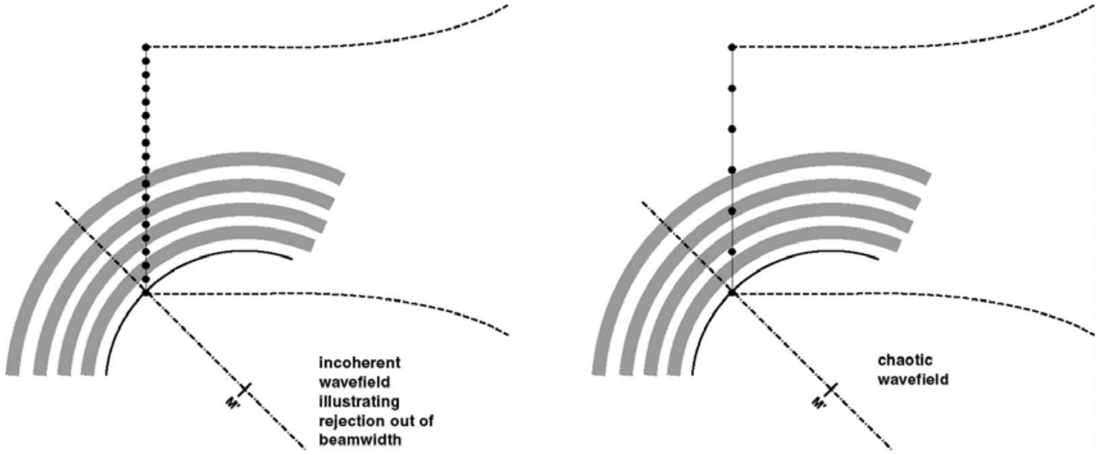


Figure 50: Destructive interference rings out of beamwidth for two kinds of line arrays : condensed and standard.

The ideal situation is achieved when sound sources get so close to each other that they become equivalent to a flat ribbon - a continuous linear source. This solves the source separation problem at higher frequencies where the wavelength is smaller than the size of the drivers (for example, $\lambda = 2$ cm at f= 16 kHz) since the chaotic, multiple source wavefield is replaced by a single well-defined wavefront.

With further analysis, we show in the first AES preprint that optimized coupling can be achieved in two ways:

- the first way is to minimize the spacing of sound source acoustic centers to less than half the smallest wavelength (corresponding to the upper frequency of their operating bandwidth)
- the second way is to shape the radiated wavefront of the sound sources into a flat isophasic ribbon, with no more than 20% discontinuity of the radiating area.

In the second AES preprint entitled "Wavefront Sculpture Technology", these two WST Criteria were re-derived based on an intuitive approach using Fresnel analysis and in addition it was shown that:

- The deviation from a flat wavefront must be less than $\lambda/4$ at the highest operating frequency (this corresponds to less than 5 mm curvature at 16 kHz and the DOSC waveguide provides less than 4 mm of curvature).
- For curved arrays, enclosure tilt angles should vary in inverse proportion to the listener distance (geometrically this is equivalent to shaping variable curvature arrays to provide equal spacing of individual element impact zones)
- Limits exist given the vertical size of each enclosure and the relative tilt angles that are allowed between enclosures.

REFERENCES:

C. Heil, M. Urban, “Sound Fields Radiated by Multiple Sound Source Arrays”, preprint #3269, presented at the 92nd AES Convention, Vienna, March 24-27, 1992

M. Urban, C. Heil, P. Bauman, "Wavefront Sculpture Technology", preprint # not available, prepared for the 111th AES Convention, New York , Sept 2001

APPENDIX 3:
HOW DOES V-DOSC BEHAVE WITH RESPECT TO WST CRITERIA

The first Wavefront Sculpture Technology criterion: STEP < smallest λ/2 over the frequency range of operation is fulfilled by a V-DOSC array at low and mid frequencies.

With reference to Figure 51,

The 15" speakers are separated by no more than 0,75 m and the crossover frequency is 200Hz, corresponding to $\lambda/2 = 0.85$ m.

The 7" speakers are separated by no more than 0.17 m and the crossover frequency is 1300Hz, corresponding to $\lambda/2 = 0.13$ m.

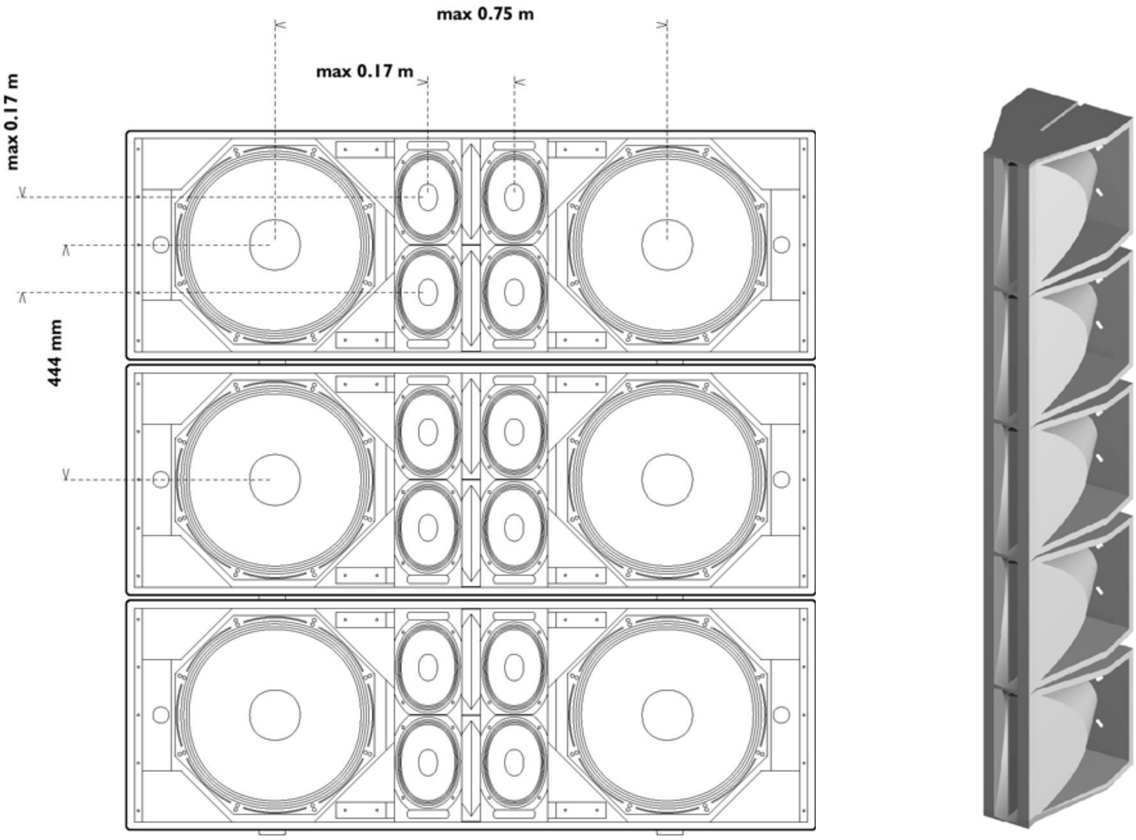


Figure 51: Front view of V-DOSC array and vertically stacked DOSC waveguides

We obviously have to fulfill the second WST criterion at higher frequencies, since it is not possible to satisfy the first one for these frequencies. This is achieved by mounting a DOSC waveguide on the exit of each driver – this shapes the wavefront into a rectangular constant phase source. Arraying DOSC waveguides and drivers then creates a flat isophasic ribbon that fulfills the second WST criterion, i.e., the overall radiating area is more the 80% of the target area provided that the angle is less than 5 degrees between enclosures.

APPENDIX 4:
HOW DOES THE DOSC WAVEGUIDE WORK?

There is no mysticism surrounding the DOSC waveguide. It is simply the result of careful analysis of the wave path through the waveguide and the resulting wave-front shape.

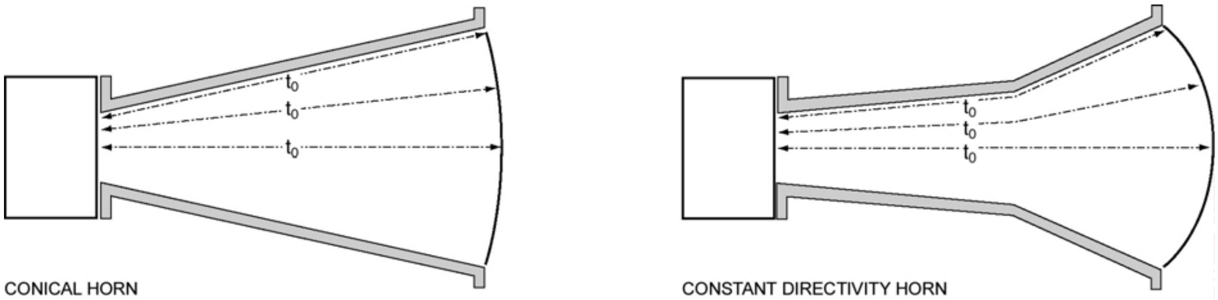


Figure 52: Horn Generated Wavefronts

With respect to Figure 52, the wavefront emerging from a horn is the result of constant time arrivals for all possible wave paths radiated by the driver exit. The two examples shown in Figure 52 produce more or less curved wavefronts that obviously cannot meet the second WST criterion.

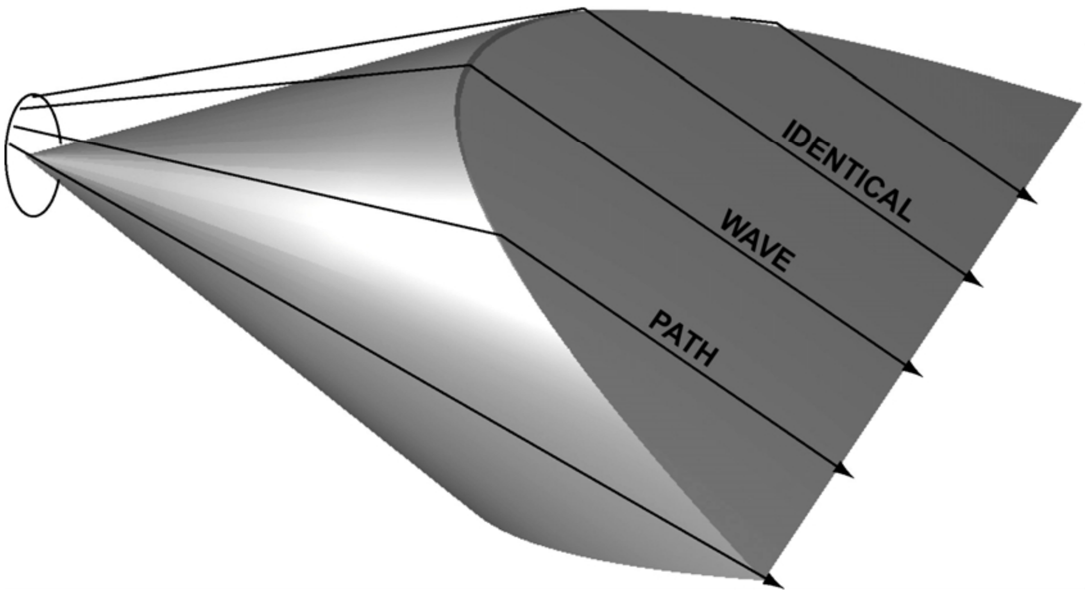


Figure 53: DOSC Waveguide – Internal Section

By comparison, the DOSC waveguide acts as a time alignment plug, delaying the arrival times of every possible wave path to be the same value at the rectangular exit of the device. The internal plug is a truncated conical piece that looks like a "tomahawk". This plug and its outer housing are precisely constructed according to specific ratios between depth, height and cone angle in order to produce the flat constant phase wavefront and tight manufacturing tolerances are obtained through the use of computer aided design and manufacturing (CAD/CAM) techniques. As shown in the AES preprint entitled "Wavefront Sculpture Technology", the deviation from a flat wavefront must be less than $\lambda/4$ at the highest operating frequency - this corresponds to less than 5 mm of curvature at 16 kHz and experiments have shown that the DOSC waveguide provides less than 4 mm of curvature.

DOSC waveguide technology is patented on an international basis.
(n°0331566 in Europe, n°5163167 in North America).

APPENDIX 5:
THE BORDER BETWEEN FRESNEL AND FRAUNHOFER REGIONS

This appendix summarizes theory presented in “Sound Fields Radiated by Multiple Sound Source Arrays”, AES preprint n°3269 (presented at the 92nd AES convention in Vienna, March 1992).

Let's assume that the V-DOSC array is flat and radiates a cylindrical wavefront. The emerging wave will progressively expand to a spherical wave at a certain distance, which depends on both the frequency and the height of the array.

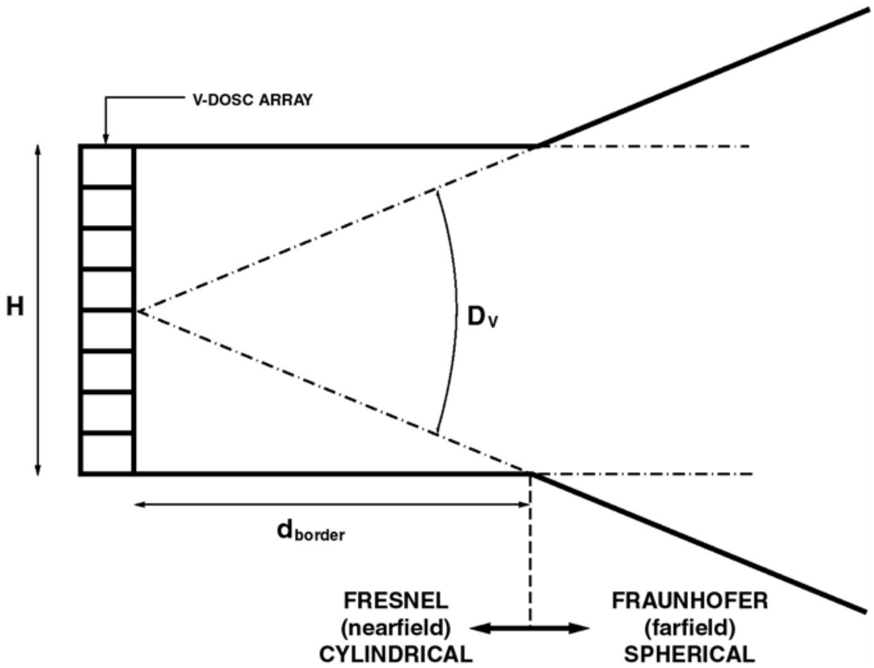


Figure 54: Illustration of the Fresnel and Fraunhofer regions

The border between CYLINDRICAL (near field = Fresnel) and SPHERICAL (far field = Fraunhofer) zones can be expressed as:

$$d_{border} = \frac{3}{2} H^2 F \sqrt{1 - \left(\frac{1}{3HF}\right)^2}$$

where:
H = height of the array (in m)
F = frequency expressed in kilohertz
d_{border} = extension of the cylindrical soundfield with respect to the source (in m)

In the Fresnel region, the wavefront is cylindrical and expands only in the horizontal dimension (nominally 90° for V-DOSC). The height of the wavefront is equal to the height of the array.

In the Fraunhofer region, the wavefront is spherical and expands in both horizontal & vertical dimensions. The horizontal coverage angle is nominally 90° and the vertical coverage angle is

$$D_V = 2 \sin^{-1}\left(\frac{0.6}{3HF}\right)$$

where D_v is the vertical coverage angle angle in (°).

The two following tables display numeric data for d_{border} and D_v, with respect to the number of V-DOSC elements arrayed:

Table 16: Border (in m) Between Cylindrical (Fresnel) and Spherical (Fraunhofer) Zones

Freq (Hz)	2 Elements H=0.9 m d_{border} (m)	4 Elements H=1.8 m d_{border} (m)	8 Elements H=3.6 m d_{border} (m)	12 Elements H=5.4m d_{border} (m)
63	No cylindrical	No cylindrical	No cylindrical	1
125	No cylindrical	No cylindrical	2	5
250	No cylindrical	1	5	11
500	0	2	10	22
1k	1	5	19	44
2k	2	10	39	87
4k	5	19	78	175
8k	10	39	156	350
16k	19	78	311	700

Table 17: Dv - Vertical Coverage Angle in the Farfield Region

Freq (Hz)	2 Elements H=0.9 m D_v (deg)	4 Elements H=1.8 m D_v (deg)	8 Elements H=3.6 m D_v (deg)	12 Elements H=5.4m D_v (deg)
63	-	-	124	72
125	-	125	53	34
250	125	53	26	17
500	53	26	13	8.5
1k	26	13	6.4	4.2
2k	13	6.4	3.2	2.1
4k	6.4	3.2	1.6	1.1
8k	3.2	1.6	0.8	0.5
16k	1.6	0.8	0.4	0.3

At 1 kHz a flat V-DOSC array of 8 elements (H=3.6 m) radiates a wavefield that is cylindrical over a distance of 19 m. Beyond this distance, the wavefield becomes spherical, and the coverage angle is 6° (i.e., the wavefront at 1 kHz is defined by the height of the array up to 19m and broadens by +/- 3° starting at d_{border} = 19 m). For a person located less than 19m from the sound source, frequencies below 1kHz are radiated in spherical mode with an attenuation rate of 6 dB per doubling of distance. All frequencies higher than 1kHz propagate in cylindrical mode with an attenuation rate of 3 dB per doubling of distance.

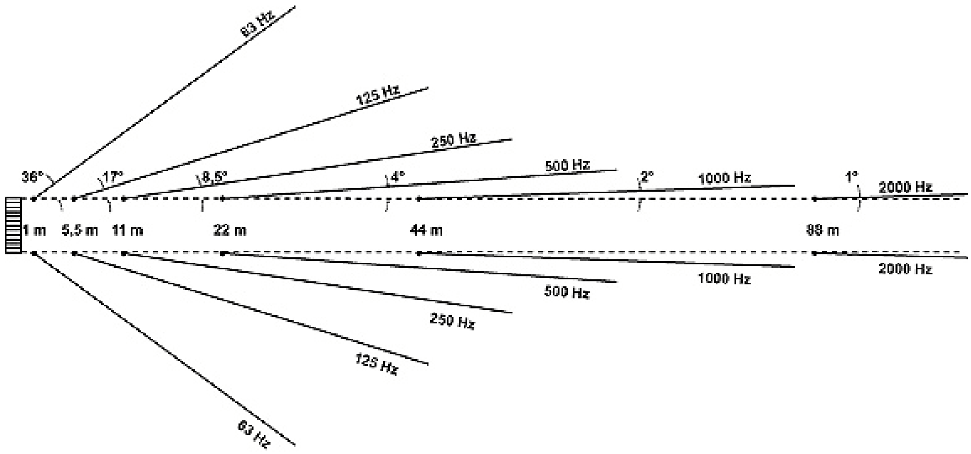


Figure 55: Illustration of dborder and Dv for a flat 12 element array

APPENDIX 6:
PATTERN CONTROL OF A CONSTANT CURVATURE ARRAY

In practice, the vertical coverage angle is controlled for frequencies greater than frequency F_1 where:

$$F_1 = \frac{444}{N\sin\left(\frac{NA}{2}\right)}$$

and N is the number of elements, A is the angle between elements in degrees.

At F_1, the vertical coverage angle is equal to the nominal value for the array, i.e., N x A degrees. At higher frequencies, the coverage decreases to a value which is approximately equal to 2/3 of N x A. This defines the minimum vertical coverage angle for the whole frequency range and is termed the "beaming" frequency F_3. Vertical coverage angle then increases up to the nominal value at F_2, defined by:

$$F_2 = \frac{1.77x10^5}{AN^2}$$

For frequencies higher than F_2, the vertical coverage angle is constant.

For instance, a curved array comprised of 8 V-DOSC elements, with a constant curvature of A = 4°, provides constant 32° vertical coverage above F_2 = 1388 Hz, with narrower coverage between F_1 = 201 Hz and F_2 and with a broadening of coverage below F_1, subject to the laws of diffraction that govern spherical wave propagation.

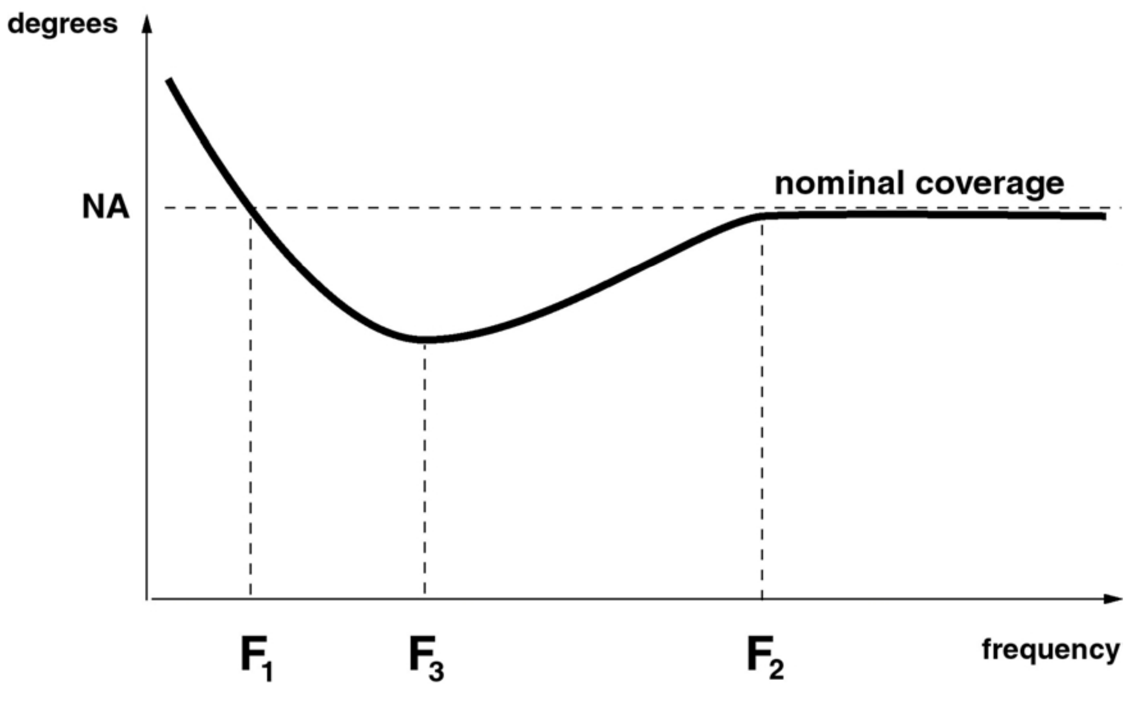


Figure 56: Illustration of the variation of vertical coverage angle with frequency

APPENDIX 7:
V-DOSC RIGGING CERTIFICATION

BUREAU VERITAS

Affair : Heil Acoustics - V DOSC System
Hanging system of loudspeakers

N° : CR51B950374C

1. PURPOSE OF THE REPORT

The present report deals with an hanging system device of loudspeakers for the V DOSC system of HEIL ACOUSTICS. Our mission consists in checking the stability of the works in reference to applicable French and European standards. We have checked the shop drawings to be used for the manufacturing.

A site visit enabled us to check the manufacturing of an hanging system and to be present at a hoist intervention in a real usage configuration.

2. REFERENCES

a/ Applicable rules

- Rules CM 66 for steel
- AL rules for aluminium (July 1976)
- CB 71 rules for timber (speaker boxes)
- European rules for steel : Eurocode 3 DAN
- Rules of the Fédération Europóeene de Manutention (for the sizing of the structure specified on drawings).

b/ Load assumption

Proper weight of the bumper : 62 daN
Fitted speaker : 108 daN

In a maximum configuration, it is planned to hang 16 loudspeakers to the bumper. The maximum load to hang is therefore 1 790 daN to which the weight of the tackles and links must be added.

3. DESCRIPTION OF THE HANGING SYSTEM (refer to sketch 14 in annex)

The bumper (hanging frame) is hanged by shackles , links and 2 tackles to the load-bearing structure of a building.

Under the bumper, a set of loudspeakers (maximum 16) is hanged. There are connected at the back by U-axes.

Laterally, AVIA rails (fixed to loudspeakers) are inter-connected by adjustable links. The purpose of this system is to ensure an angular orientation between the loudspeakers for the sound diffusion. Therefore, only the system by U-axes is provided to bear the weight of the loudspeakers. Sketches 1 to 20 correspond to various parts of the hanging system.

4. HOIST INSTRUCTIONS

The hoist intervention is described in annex (paragraph 3.3. Installation of a suspended - 4 sheets). Make sure before implementing the hoist that the anchorage points on the building have the capacity of bearing the loading planned (refer to the load assumptions).

BUREAU VERITAS

Affair : Heil Acoustics - V DOSC System
Hanging system of loudspeakers

N° : CR51B950374C

5. ASSESSMENT ON THE HANGING SYSTEM

a/ Technical dossier forwarded (folios 1 to 20 + assembly instructions attached)

Documents provided are satisfying as for the stability in reference to standards and rules of chapter II. Refer also to our assessment on execution documents attached.

b/ Factory visit on 22/12/95

We had a visual check of the hanging system, then we saw the hoist intervention of the whole set : we have no remark to make.

We issue a FAVOURABLE ASSESSMENT on the V. DOSC hanging system.

This ASSESSMENT is valid during 3 years i.e. limit date : june 21, 2002.

Issued in Noisiel, on October 10, 1996
Translated in Paris, on November 27, 1998
Modified on june 21, 1999

HEAD OF THE SPECIALISED TECHNICAL DEPARTMENT

P.o D. VIBURNI

GEORGES MARCHAND

FRAMEWORK EXPERT

DANIEL BERGER
☎ 01 55 56 60 64